SIGNAL GENERATOR
MODEL 2500
OPERATING MANUAL

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REV A

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USE OF THIS MANUAL

The documentation package for the Wavetek Model 2520 RF Signal Generator consists of an Operating Manual and a Service Manual. This is the Operating Manual. It contains seven sections.

Section 1 Provides general information about the unit, including specifications.

Section 2 Contains detailed installation instructions. Instructions proceed from the initial inspection (after unpacking a unit) to the instrument checkout procedure after installation is completed.

Section 3 Provides operating instructions for the unit.

Section 4 Contains the performance tests used to verify that all functions of the unit work properly.

Section 5 Contains the maintenance instructions for the unit, including the AutoCal® procedure, user diagnostics, and a field calibration procedure.

Section 6 Contains documentation for the GPIB option.

Section 7 Provides documentation for the Phase Modulation option and the Pulse Modulation option.

Changes that must be made to this manual are supplied as separate inserts. Change may occur for various reasons. Wavetek's product improvement program incorporates the most current technology into these instruments as rapidly as development and testing will permit. Due to the time required to document and print instruction manuals it is not always possible to include information about product improvements in the original printing for a manual.

The Service Manual is an optional item. It contains Theory of Operation, Troubleshooting Notes, Reference drawings (schematics and assembly), and Replaceable Parts Lists. Schematics and their associated assembly drawings are grouped together.

Please note that each of the figures in this text has a ten digit identification number (xxxx-xx-xxxx). For example, the Wavetek identification number for Figure 3-1 is 6510-03-0002. These numbers are for internal use by Wavetek only.

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1.1 INTRODUCTION

The Wavetek Model 2520 is a microprocessor controlled, single-loop synthesized signal generator that has a specified frequency range from 200 kHz to 2200 MHz. Standard features include a very broad 1.999 MHz peak FM deviation, an exclusive AutoCal® self-calibration function, extensive user diagnostics, an automatic power up test sequence, and nonvolatile memory locations to store up to 64 different complete front panel settings. The operator may recall the next complete front panel setting above or below the current one by pressing a single key. Frequency, modulation, and output level may be increased or decreased in discrete steps, programmed by the operator. The GPIB address for the 2520 and the end of string terminator may be programmed from the front panel. A 10 MHz square wave reference output is available at the rear panel.

All operational controls are located on the front panel. Controls include keypad switches and a spin knob for entry of all RF output numeric parameters. The spin knob provides entry that has the ease and continuity and fine tuning of analog control. Instrument settings are indicated on three custom LCD displays with electroluminescent backlighting.

The 2520 is a full rack size unit. (Two optional rack mount adaptor kits are available.)

A talk/listen GPIB fully conforming to the IEEE-488 standard is optional with the Model 2520. Because it utilizes the minimum uniqueness concept, the Model 2520 can be easily conformed to any ATE system. Programs written for the Wavetek Models 2500 and 2500A synthesized signal generators are fully compatible with the Wavetek Model 2520. (Additional options are listed in Section 1.2.15.)

1.1.1 FREQUENCY CHARACTERISTICS

The carrier frequency may be set from 0.2 to 2200 MHz with 10 Hz resolution below 1100 MHz and 20 Hz resolution above 1100 MHz. Specified accuracy is 2.5 ppm (.00025%) with greater accuracy available as an option (see Section 1.2.15).

1.1.2 MODULATION CHARACTERISTICS

The instrument features both internal and external AM and FM capabilities. The internal modulation source may be set at a 400 or 1000 Hz rate. AM depth is from 0 to 100%. FM deviation can be set from 0 - 500 kHz for carrier frequencies between 137.5 MHz and 275 MHz, from 0 to 1 MHz at all other carrier frequencies less than 1100 MHz and from 0 to 1.999 MHz for frequencies greater than 1100 MHz. FM resolution is from 10 Hz to 2 kHz depending upon the deviation set (see Section 1.2.7.2 for greater detail). The external reference input may be a sine or square wave at 1 MHz, 5 MHz, or 10 MHz.

Internal and external sources may be used simultaneously to produce complex modulation.

1.1.3 OUTPUT LEVEL CHARACTERISTICS

The Model 2520 has an RF output range of +13 dBm to -137 dBm with an output level flatness of ±1.2 dB (±0.7 dB, typical). The level resolution is .1 dB.

Output level may be read in dBm, mV, or µV. Reverse power protection to 50 watts is standard.

1.1.4 AutoCal®/DIAGNOSTICS

The Model 2520 utilizes a unique AutoCal® routine to perform a quick and easy, almost completely automatic self-calibration. The AutoCal® routine is one of twenty-two procedures activated by turning a rear panel keylock switch. Nineteen of the remaining twenty-one procedures are user diagnostics. (The twentieth procedure enables the operator to set the GPIB address and the GPIB end of string terminator from the front panel. The twenty-first enables the operator to display the options that have been programmed into the instrument.)

1.1.5 STORED SETTINGS

Nonvolatile memory locations allow up to 64 complete front panel settings to be stored and recalled in any order. This storage permits fast and accurate recall of frequently used settings. Settings may be recalled in sequence (up or down) by pressing a key at each increment.

The 2520 powers up with the same settings present when power was removed, except the RF output will be off at power up.

1.1.6 ERROR INDICATORS

The front panel displays for the 2520 indicate the following error conditions:

- An unlocked condition in the phase locked loop circuitry
- An unleveled condition in the RF output leveler circuitry
- A tripped RF circuit breaker
- FM overmodulation

1.2 SPECIFICATIONS

1.2.1 FREQUENCY

Range	.2 - 2200 MHz, specified
Resolution	10 Hz <1100 MHz 20 Hz >1100 MHz
Frequency Stability/Temp	±2.5 ppm (±.00025%), 0-50° C
Frequency Stability (Aging)	<1 ppm/yr.
Switching Speed	Typically 100 mSec (200 mSec, maximum).

1.2.2 RF OUTPUT

Impedance	50Ω (VSWR <1.6:1 for output <-7 dBm)
Output Connector	Type "N"
Calibrated Level Range	+13 to -137 dBm
Level Resolution	.1 dB

Level Accuracy	±1.5 dB for power levels >-37 dBm; ±1.5 + (0.1/10 dB step decrease) dB for power levels <-37 dBm and frequencies <1100 MHz; ±1.5 + (0.2/10 dB step decrease) dB for power levels <-37 dBm and frequencies >1100 MHz;
Flatness	±1.2 dB (±0.7 dB, typical)
EMI/RFI Leakage	<0.5 µV into a 2-turn 1 inch diameter loop 1 inch from any surface at 1100 MHz Conforms to MIL-T-28800C, Class 5, FCC and VDE.

1.2.3 SPECTRAL PURITY

Harmonics	<-25 dBc from 0.2 MHz to 0.4 MHz <-30 dBc from 0.4 MHz to 1100 MHz <-25 dBc >1100 MHz
Sub-Harmonics (500 MHz - 2200 MHz)	<-25 dBc
Non-Harmonics (Spurs) (>5 kHz from carrier)	<-50 dBc for carrier frequencies <137.5 MHz <-60 dBc for carrier frequencies from 137.5 MHz to 1100 MHz <-54 dBc for carrier frequencies >1100 MHz
(<5 kHz from carrier)	<-50 dBc, typically, for all frequency ranges

1.2.4 PHASE NOISE @ 500 MHz

10 kHz offset	<-107 dBc/Hz guaranteed (Typ -110 dBc/Hz)
20 kHz offset	Typ <-115 dBc/Hz

1.2.5 RESIDUAL AM

(.05 - 15 kHz PDBW)	<-65 dBc

1.2.6 RESIDUAL FM

(.05 - 15 kHz PDBW)	<30 Hz rms (.2 - 137.5 MHz) <10 Hz rms (137.5 - 275 MHz) <20 Hz rms (275 - 550 MHz) <40 Hz rms (550 MHz - 1100 MHz) <80 Hz rms (>1100 MHz)
(.3 - 3 kHz PDBW)	<15 Hz rms (.2 - 137.5 MHz) < 7 Hz rms (137.5 - 275 MHz) <10 Hz rms (275 - 550 MHz) <20 Hz rms (550 MHz - 1100 MHz) <40 Hz rms (>1100 MHz)

1.2.7 MODULATION

Modes	AM, FM, COMPLEX (EXT AM and INT FM; EXT FM and INT AM)

Internal Source	400 Hz, 1 kHz; derived from frequency standard
External Source	AM Mode: DC to 15 kHz, 600 Ω input FM Mode: 20 Hz to 100 kHz, 600 Ω input

1.2.7.1 AM CHARACTERISTICS

AM Frequency Response (0 - 50%)	DC to 15 kHz (Typ to 20 kHz)
AM Resolution	0.1%
AM Range	0 - 100%
Modulation Accuracy, AM (0 - 90%)	±(2% + 6% of setting); 0.2 MHz to <1 MHz ±(2% + 4% of setting); 1 MHz to <1100 MHz ±(2% + 6% of setting); 1100 MHz to <2200 MHz
AM Distortion (at 1 kHz rate)	<1.5%, below 30% modulation <3%, 30% to 70% modulation <5%, 70% to 90% modulation

1.2.7.2 FM CHARACTERISTICS

FM Resolution	
Frequency <1100 MHz	10 Hz (deviations <10 kHz) 100 Hz (deviations <100 kHz) 1 kHz (deviations <1 MHz)
Frequency >1100 MHz	20 Hz (deviations <10 kHz) 200 Hz (deviations <100 kHz) 2 kHz (deviations <1 MHz)
FM Rate	20 Hz - 100 kHz 0 Hz - 100 kHz (with FSK Option)
FM Deviation Range (1 kHz Rate)	1 MHz peak (3 - 137.5 MHz) 500 kHz peak (137.5 - 275 MHz) 1 MHz peak (275 - 1100 MHz) 1.999 MHz peak (>1100 MHz)
Modulation Accuracy, FM	±6%, at internal rates (typically ±3%)
FM Distortion	<2% at internal rates at deviation <100 kHz, not including residual FM; 0.2% for external source, typical

1.2.8 FRONT PANEL CONTROL

Type	Push-buttons, Spin-Knob, GPIB

1.2.9 REVERSE POWER PROTECTION

Max RF Power	50 W
Trip Level	~ 0.7 W

Trip Time	Typically <1 mSec; <2 mSec, maximum
Max Reverse DC Voltage	50 V

1.2.10 STORED SETTINGS

64 Total	Complete front panel settings stored in non-volatile memory

1.2.11 EXTERNAL REFERENCE INPUT (REAR PANEL)

Frequency	1, 5, or 10 MHz
Required Input Level/Impedance	1-5 Vp-p, into 50 Ω
Waveform	Sine or Square Wave

1.2.12 INTERNAL REFERENCE OUTPUT (REAR PANEL)

Frequency	10 MHz
Voltage Out/Impedance	100 mVp-p, into 50 Ω
Waveform	Square Wave

1.2.13 GENERAL

Dimensions	14 cm (5.5 in.) High; 43.18 cm (17 in.) Wide; 53.3 cm (21 in.) Deep
Weight	16.34 kg (36 lbs.)
Power	100 or 120, 220 or 240 VAC; 50-400 Hz; 110 W

1.2.14 ENVIRONMENT

MIL-T-28800C Class 5

0 - 50°C Operating Temperature

1.2.15 OPTIONS

1.2.15.1 GPIB Remote Programming	The GPIB Option gives the 2520 remote programming of front panel functions via GPIB. Command codes conform to TEK codes and formats of Tektronix Standard 80009, Rev. C, 1979.
Interface	GPIB IEEE-488-1978
Control	All functions except On/Off, AutoCal® and Diagnostics
Functions	T6, L4, SH1, AH1, RL1, DC1, DT1, E2, SR1, TE0, LE0, PP0, C0

1.2.15.2 R01 0.5 PPM Reference	The R01 Option meets requirements for many communications applications. A TCXO is used to maintain stability over the 0 to 50°C range.
Frequency Stability	0.5 ppm
Aging	1 ppm/year
1.2.15.3 R02 0.05 PPM Reference	The R02 Option uses a new DCXO (Digitally Compensated Crystal Oscillator) which improves the stability over a normal TCXO's. There is also no warm up time as in ovenized oscillators.
Frequency Stability	0.05 ppm
Aging	0.5 ppm/year
1.2.15.4 NA No Attenuator	The NA Option is cost-saving and used when levels between +13 and -7 dBm only are needed. Reverse Power Protection is removed from the instrument.
RF Output	
SWR	<2.0:1
Level Range	-7 to +13 dBm
Resolution	0.1 dB
Accuracy and Flatness	±1.2 dB
Reverse Power Protection	None; No DC Block
1.2.15.5 FSK FSK Modulation	The FSK Option provides symmetrical, DC coupled, binary carrier frequency shift keying for the 2520. The system is an optimal hybrid of digital and analog modulation techniques, virtually eliminating the loop lock transient which inevitably results from simple synthesizer-based FSK. The advantages of analog FM systems are retained (reproduction of code waveshape), but with no waveform tilt. The frequency drift associated with conventional DC FM systems is eliminated, and the frequency stability is solely a function of the instrument frequency reference. The system features an internal "return to center frequency" (RTC) function which inhibits the FSK mode and returns the synthesizer to center frequency. The RTC function is compatible with Motorola's Universal Encoder system and enables the sequential transmission of FSK and analog voice or tone information without requiring external mode switching.
Deviation	±4.95 kHz max
Resolution	10 Hz

Baud Rate	0 - 20 Kbps
Tilt	Zero - can dwell indefinitely on mark or space
Waveshape	User-defined
Deviation Accuracy	±5% of setting with ±1 VP code input
Carrier Frequency Stability	Same as frequency reference
Analog FM Frequency Response	20 Hz - 100 kHz
Analog FM Deviation	If external FM + FSK is used, the sum of the peak deviations of each must not exceed 9.99 kHz.
FSK Modes	
Symmetrical	+1 V = shift up -1 V = shift down 0 V = center frequency
Code Input	±1 V; 0 ±10 mV Zero state 600 ohms unbalanced
Miscellaneous	No FSK + Internal FM FSK + External FM is available No FSK + External AM

1.2.15.6 PHM Phase Modulation

The PHM Option gives the 2520 the ability to do phase modulation. Phase modulation is enabled by a key on the front panel. With phase modulation enabled, the modulating signal can be connected to MOD IN on the front panel.

Peak Phase Modulation	20 rad (3 - 173.5 MHz) 10 rad (137.5 - 275 MHz) 20 rad (275 - 2200 MHz)
Bandwidth	20 Hz - 50 kHz
Accuracy	±6%

1.2.15.7 PUL Pulse Modulation

The PUL Option adds a pulse modulator to the 2520. The modulator is a unique combination of hybrid and GaAs FET technologies to provide an excellent on/off ratio and repetition rate.

RF Output	+10 dBm to -137 dBm
On/Off Ratio	80 dB minimum
Rise and Fall Time	25 nsec
Pulse Enable (with rear panel switch off)	TTL: +5 V "ON"

Modulating Pulse Levels	TTL: +5 V = "ON" state (switches at 1.5 V) 0 V = "OFF" state (switches at 1.4 V) Negative drive available; contact factory
1.2.15.8 RPC Rear Panel Connectors	The RPC Option moves the front panel RF Out and Mod In connectors to the rear panel.
1.2.15.9 K-0295 Rack Mount (P/N 1019-00-0295) K-0294 Rack Mount with Slides (P/N 1019-00-0294)	The K-0295 option is used to mount the 2520 in a fixed position in a standard 17 inch rack. The K-0294 Rack Mount K-0294 option is used to mount the 2520 on slides in a standard 17 inch rack. With the slides extended, the unit can be tilted to several different angles for easy servicing.
1.2.15.10 COV	Front Panel Cover

SECTION 2

INSTALLATION INSTRUCTIONS

2.1 INTRODUCTION

This section provides complete installation instructions for the Wavetek Model 2520 Synthesized RF Signal Generator. These instructions include the initial inspection required for the unit and contain information on mechanical installation, electrical installation, and the initial installation checks.

2.2 INITIAL INSPECTION

After unpacking the instrument, visually inspect external parts for damage to connectors, surface areas, etc. The shipping container and packing material should be saved in case it is necessary to reship the unit.

2.2.1 DAMAGE CLAIMS

If the instrument received has been damaged in transit, notify the carrier and either the nearest Wavetek area representative or the factory in Indiana. Retain the shipping carton and packing material for the carrier's inspection. The local representative or the factory will immediately arrange for either replacement or repair of your instrument without waiting for damage claim settlements.

2.3 MECHANICAL INSTALLATION

2.3.1 Mechanical installation instructions are limited to those steps required to install the 2520 into a rack using the optional rack mount adaptor kits available from Wavetek.

2.3.2 Wavetek manufactures two rack mount adaptor kits, one without slides and one with slides. The rack mount adaptor kit without slides (Wavetek part number 1019-00-0295) provides a fixed, immovable unit mount. The rack mount adaptor kit with slides (Wavetek part number 1019-00-0294) allows the unit to be pulled out from the rack and tilted for easy servicing.

2.3.3 Complete installation instructions are supplied with the hardware for either kit.

2.4 ELECTRICAL INSTALLATION

The instrument can operate from 100, 110, 220, or 240 VAC supply mains, over an AC supply frequency range from 50 to 400 Hz. The rear-panel AC power connector module is set for the operating voltage used, and adjusts the Power Supplies accordingly.

The AC power connector module connects to an AC supply via a line cord with a 3-prong plug. The module contains a time-delay line fuse: 1 A for 100/120 VAC operation; 0.5 A for 220/240 VAC operation. The fuse and a clearly marked voltage selector are accessed when the fuse/voltage select compartment door is open (see Figure 2-1).

Instruments are shipped from the factory set up for 120 VAC operation unless otherwise specified.

Figure 2-1. AC Power Connector Module

NOTE

Before operating the instrument, check that the rear-panel AC fuse is the correct value for the supply voltage.

2.5 INSTALLATION CHECKS

Wavetek performs a rigorous and complete test/calibration of each 2520 before it leaves the factory. Because accidents can occur during shipment, the user may elect to perform any or none of the following functional checks to further verify proper operation. It is the user's responsibility to determine the degree to which the unit will be tested initially (upon receipt).

Any time power is applied to the Model 2520, it automatically performs a test sequence to verify various subsystems and subsystem circuitry is functional. That power up test sequence is described in Section 5.6 of this manual.

The following installation check procedures provide a quick functional test to verify that the instrument (total system) is operating properly. If the user desires to verify operation at specification limits, the performance test procedures in Section 4 of this manual must be used.

The functional test procedures involve use of the front panel controls and displays. Controls and displays are described in detail in Section 3 of this manual. Please read Section 3 before initiating operation.

AutoCal®, the almost completely automatic self-calibration procedure for the instrument, is contained in Section 5 of this manual. If it is determined that the unit is not operating properly, perform the AutoCal® procedure, then retest.

2.5.1 REQUIRED TEST EQUIPMENT

The test equipment required to perform the following installation checks will depend upon the degree to which the user wants to verify the instrument. If the desire is to verify to specification, the user should proceed to Section 4 and complete the performance tests detailed there. The installation checks described in the next few paragraphs are intended to provide a functional test of the unit. The operator will verify the output frequency, modulation, and power levels are accurate to the limits of the test equipment used and that the output characteristics change when programmed to change. The following tests are general in nature because the operator may use the test equipment on hand (spectrum analyzer, modulation analyzer, oscilloscope, power meter, etc.) to perform them. Wavetek does not recommend specific test equipment to use for these initial functional tests.

2.5.2 TURN ON

Verify that the voltage selector is set to select the available line voltage, and that the proper fuse is installed (see Section 2.4). Verify that the EXTERNAL/INTERNAL REFERENCE switch on the rear panel is in the appropriate position (read Section 3.4, item 3). If the internal reference source is used, this switch must be in the INT position. (If this switch is not in the

INT position when the internal reference is used, the power up self test will give an error 18 message and the unit will not operate. Read Sections 5.6 through 5.6.2 for greater detail.) Depress the POWER switch. The displays will indicate operation. The LEVEL display will indicate RF OFF. Press the RF ON/OFF key to turn on the RF.

2.5.3 TEST PROCEDURE

The following paragraphs briefly outline a general functional test procedure for the 2520. Verify measurements to the limits of the test equipment used, if desired.

2.5.3.1 FREQUENCY

Use the keyboard (Section 3.5.2.1) to set the output frequency to 500 MHz at a 0 dBm power level, with no modulation. Measure the output frequency. Use the spin knob (Section 3.5.2.2) to change the output frequency to 1000 MHz. Measure the output frequency. Use the keyboard to set output frequency to 2000 MHz. Measure the output frequency. Use the spin knob to change the frequency to 1500 MHz. Measure the frequency. Use the keyboard to set the frequency to 100 MHz. Measure the frequency. Use the spin knob to set the frequency to 200 MHz. Measure the frequency.

Set the step frequency to 5 MHz (Section 3.5.5.2). Press the FREQ pushbutton. Press the ↑ and ↓ keys and verify the frequency increases and decreases in 5 MHz steps.

2.5.3.2 OUTPUT LEVEL

Set the output frequency at .4 MHz with no modulation. Use the keyboard to set the output level at +13 dBm. Measure the output level. Use the spin knob to set the resolution digit (Section 3.5.2.2) at the units (ones) position and then to set the output to -7 dBm. Measure the output level. Verify that pressing the ↑ and ↓ keys raises or lowers the output level 1 dBm at each press. Set the output frequency to 400 MHz. Measure the output level. Use the keyboard to change the output level to +13 dBm. Measure the output level. Set the output frequency to 1100 MHz. Measure the output level. Use the spin knob to change the output to -7 dBm. Measure the output level. Set the output frequency to 2000 MHz. Measure the output level. Change the output level to +13 dBm. Measure the output level.

Set the step level to 1 dB (Section 3.5.5.4). Press the LVL pushbutton. Press the ↑ and ↓ buttons and verify the level increases and decreases in 1 dB steps.

2.5.3.3 AM

Set the output frequency at .4 MHz and level at -7 dBm. Select INT AM and the 1000 Hz internal source. Set internal AM at 90%. Measure AM. Change the output frequency to 550 MHz. Measure AM. Select the 400 Hz internal source. Measure AM.

2.5.3.4 FM

Set the output frequency to 275 MHz and the output level at 0 dBm. Select INT FM and the 1000 Hz internal source. Set internal FM deviation at 99.9 kHz. Measure the deviation. Change the output frequency to 500 MHz. Measure deviation. Select the 400 Hz internal source. Measure FM deviation.

2.5.3.5 EXTERNAL AM/FM

The user may elect to insert an external modulation source at the MOD IN connector on the front panel (item 28 of Figure 3-1) and repeat steps 2.5.3.3 and 2.5.3.4 for EXT AM and EXT FM modulation. Select EXT AM and EXT FM by pressing the appropriate keyboard switch.

SECTION 3

OPERATING INSTRUCTIONS

3.1 INTRODUCTION

This section provides the complete operating instructions for the Wavetek Model 2520 RF Signal Generator. No preparation for operation is required. The user may choose to perform the optional initial installation checks contained in Section 2 of this manual.

The 2520 may be operated locally using the front panel controls or remotely through the GPIB interface on the rear panel, under computer/controller instructions.

3.2 AIR FILTER CAUTION

Regularly check the air flow filter installed over the intake vents on the bottom of the unit. Clean as necessary. Air filter maintenance is described in the Maintenance Section of this manual.

3.3 FRONT PANEL DESCRIPTION

Front panel operating controls, displays, and connectors are shown in Figure 3-1. All controls necessary for local (manual) operation of the unit are located on the front panel, with the exception of the "OPERATE/AutoCal® keylock switch, the external reference source selector switch, and the BACK-LIGHT on/off switch on the rear panel of the unit. Front panel features are identified by number in Figure 3-1. Each numbered feature is briefly described in the following paragraph with the same number.

1. POWER

The power switch turns power on/off to the 2520.

CAUTION

Allow a 2-second time interval between turning power off and on. The fan has a current protection circuit that turns off if excess current is drawn. If the unit is turned off and on too quickly the surge current could cause the protection circuit to disengage power to the fan, resulting in possible damage to the instrument.

Keys numbered 2 through 5 are GPIB function controls and are grouped together into a keypad for operator convenience. (Please note that GPIB documentation is provided in Section 6 of this manual.)

2. LCL

If the unit is in the remote control mode of operation (GPIB), the local key may be used to reestablish front panel control of the 2520 from the remote control source.

3. SRQ

The SRQ key issues a service request message through the GPIB.

4. ADDR

The address key is used to display the GPIB address and to initiate the

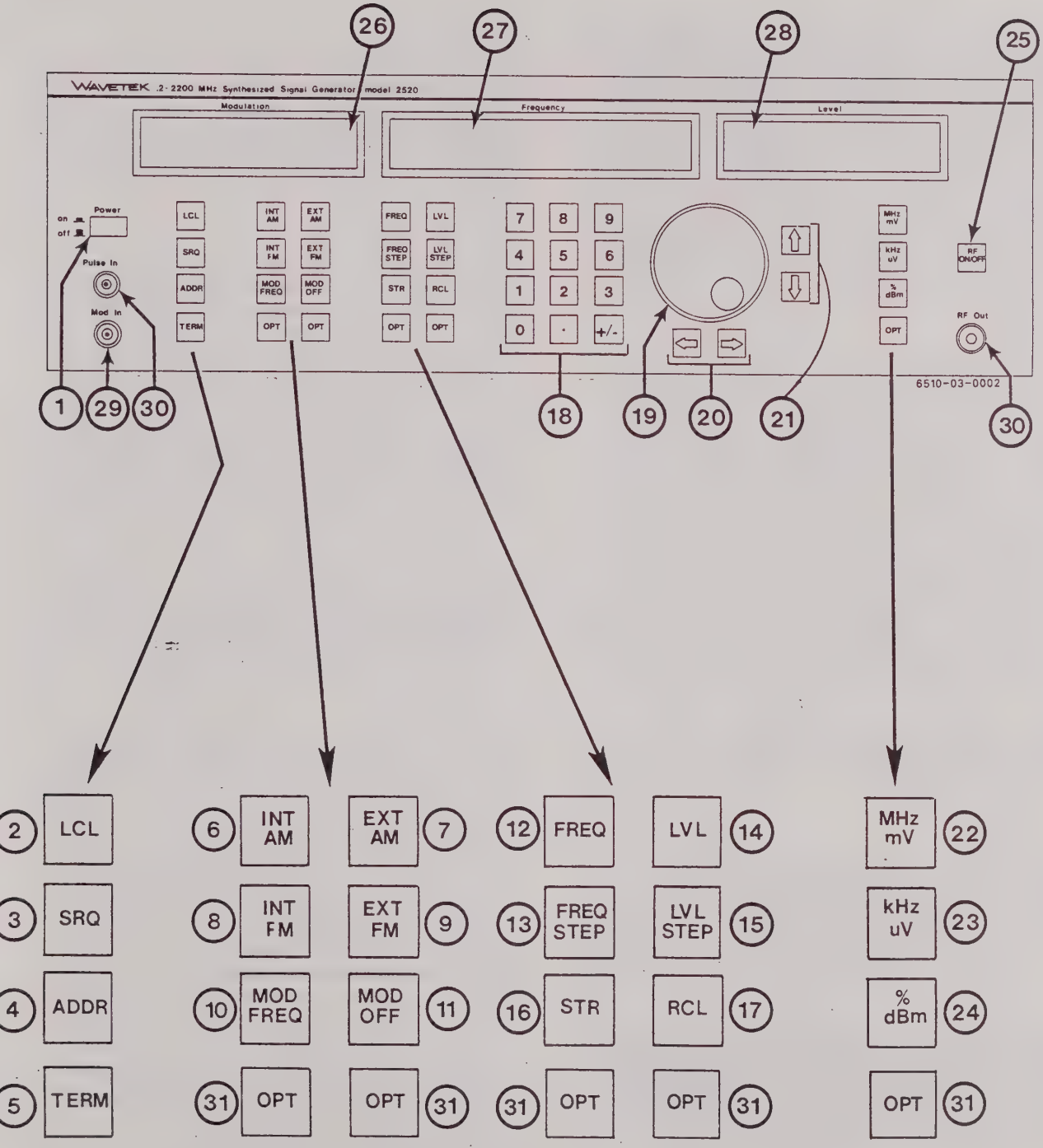

Figure 3-1. Wavetek Model 2520 Front Panel

procedure to set or change the address. When the unit is in the Local mode of operation, pressing the ADDR key will display the two digit GPIB address on the FREQUENCY display. After a second or two the address will turn off automatically. The operator must call up the user diagnostics (see Sections 5.4 through 5.4.8 and 5.4.10, entry number 21) to set/change the GPIB address from the front panel.

5. TERM

The terminator key is used to display the GPIB end of string terminator and to initiate the procedure to set or change the end of string (EOS) terminator.When the unit is in the Local mode of operation, pressing the TERM key will display the EOS terminator on the FREQUENCY display. After a second or two the terminator will turn off automatically. The operator must call up the user diagnostics (See Section 5.4 through 5.4.8 and Section 5.4.10, item 21) to set/change the EOS terminator from the front panel.

Keys numbered 6 through 11 are associated with selecting the modulation source, if any.

6. INT AM

The internal AM key selects the internal amplitude modulation mode of operation and is associated with key 10.

7. EXT AM

The external AM key selects the external amplitude modulation mode. An external source, connected at the MOD IN connector (feature 29) provides the amplitude modulation source.

8. INT FM

The internal FM key selects the internal frequency modulation mode of operation and is associated with key 10, below.

9. EXT FM

The external FM key selects the external FM modulation mode. An external source, connected at the MOD IN connector (feature 29) provides the frequency modulation source.

10. MOD FREQ

The Modulation Frequency key determines which internal source rate, 400 or 1000 Hz, provides the internal AM modulation selected by key 6, above, or the internal FM modulation selected by key 8, above. The internal rate toggles between 400 and 1000 Hz with each key stroke. The rate is displayed on the Modulation display (see item 26).

11. MOD OFF

The modulation off key turns off all modulation of the carrier wave, selecting an unmodulated CW RF output.

12. FREQ

The frequency key initiates the procedure to establish the RF output carrier frequency.

13. FREQ STEP

The frequency step key initiates the procedure to establish the step interval by which frequency is increased or decreased when the unit is in the frequency step mode (see Section 3.5.5.2).

14. LVL

The level key initiates the procedure to establish the RF output power level.

15. LVL STEP

The level step key initiates the procedure to establish the step interval by which level is increased or decreased when the unit is in the level step mode (see Section 3.5.5.4).

16. STR

The store key initiates the procedure to store front panel settings in non-volatile RAM (Random Access Memory). There is enough memory to store 64 complete front panel settings.

17. RCL

The recall key initiates the procedure to recall front panel settings from storage locations in non-volatile RAM.

18. NUMERIC ENTRY KEYPAD

Numeric data is entered using the keys grouped together in this 12 key keypad. The digits (0-9) and a decimal point (.) are represented by individual keys. The +/- key is used to establish the sign of an entry (positive/negative).

Features 19, 20, and 21 work together to allow the operator fine and coarse control of output frequency, output level, AM depth (%), and FM deviation (kHz). Use of features 19 - 21 are described in detail later in this chapter.

19. SPIN KNOB

Rotating the spin knob in a clockwise direction will increase the values listed immediately above. Counter-clockwise rotation will decrease those values.

20. ← →

The left and right arrow keys below the spin knob function as cursor keys and establish the digit in a function display (see items 26 through 28) controlled by the spin knob. This "resolution" digit and the digits to its left are controlled by the spin knob. The resolution digit is underlined on the display. Digits to the right of the resolution digit will not change as the spin knob is rotated. (The resolution digit is deactivated when the unit is in the frequency step mode of operation (see Section 3.5.5.2).

20. ↑ ↓

The up and down arrow keys function as "increment" keys and are used to increase and decrease frequency, RF output level, and modulation values in stepwise increments (see Sections 3.5.5.2 through 3.5.5.5). They also may be used to recall front panel settings in sequence (see Section 3.5.6.3).

Features 22 through 24 serve to terminate RF frequency, level, and modulation settings.

22. MHz/mV

The MHz/mV key terminates an output frequency or frequency step (MHz) or output level (mV) entry.

23. kHz/µV

The kHz/µV key terminates output frequency, frequency step, and FM deviation (kHz) and output level (µV) entries.

24. %/dBm

The %/dBm key terminates AM modulation depth (%) and output level (dBm) entries.

25. RF ON/OFF

The RF on/off key is used to toggle the RF signal on and off at the RF out connector (feature 30). The RF on/off key also resets the reverse power RF circuit breaker (see Section 3.6.2).

Features 26 through 28 are the displays that indicate operational status of the instrument and provide information about the RF output characteristics.

26. MODULATION DISPLAY

The modulation display indicates the modulation status of the RF output signal. The output signal may be unmodulated, CW, indicated by the display word "OFF". The signal may be amplitude

(AM) or frequency (FM) modulated, using an internal or external modulating source. The display annunciators are "INT AM", "EXT AM, "INT FM", and "EXT FM" for each AM or FM output. The "EXT FM DEV" annunciator indicates that the number shown on the display is the programmed FM deviation.

Complex modulation (a combination of AM and FM) may be used. AM is shown on the display as % modulation, FM as kHz deviation. The operator may select an internal modulation rate of 400 or 1000 Hz, with the selected source shown on the display. The numeric value for the AM or FM used is shown on the display. The digit controlled by the spin knob, the resolution digit (see features 19 and 20), is underlined on the display.

If an FM overmodulation error occurs (see Section 3.6.3) the display will indicate "FM OVERMOD".

The modulation display will show the annunciator REMOTE when the unit is under remote (GPIB) control.

The modulation display also contains annunciators associated with the AutoCal® and the diagnostics supplied with the Model 2520. These annunciators are described in the AutoCal® and diagnostic text in Section 5 of this manual.

27. FREQUENCY DISPLAY

The frequency display indicates the frequency of the RF carrier output in MHz. The numeric indicators include an underlined resolution digit used with spin knob control of the frequency (see features 19 and 20). This display contains annunciators that indicate an unlocked phase locked loop (UNLOCKED), the memory locations into which front panel settings are being stored (LOCATION STORED) or from which settings are being recalled (LOCATION RECALLED), and that the actual settings displayed are not those from a stored memory location (NO STORED SETTING RECALLED). When the unit is in the Frequency Step mode of operation, the annunciator FREQ STEP is displayed. An annunciator indicates when the instrument is performing an automatic frequency calibration (CAL). During automatic calibration the oscillator being calibrated (numbered 1-4) and the various calibration points (1-51, depending on the oscillator) are indicated as calibration proceeds.

A set of annunciators for the Frequency Display are associated with GPIB operation (see Section 6 of this manual for greater detail). The SRQ annunciator indicates that a service request has been issued. The GPIB ADDR annunciator indicates that the two digit number accompanying it is the GPIB address for the unit. The TERM annunciator indicates that the GPIB end of string (EOS) terminator accompanying it is the EOS terminator in use. The (EOS) terminator will be one of the following annunciators:

LF
LF/EOI
CR/LF/EOI
LAST CHAR/EOI

The frequency display also contains annunciators associated with the AutoCal® and the diagnostics supplied with the Model 2520. These annunciators are described in the AutoCal® and diagnostic text in Section 5 of this manual.

28. LEVEL DISPLAY

The level display indicates the level of the output RF signal in dBm, mV, or µV. The numeric indicators include an underlined resolution digit used with spin knob control of the output level (see features 19 and 20). This display also contains annunciators that indicate when the RF circuit breaker is tripped (TRIPPED), when the leveler circuits are not functioning (UNLVD), and whether the RF output is on or off (RF ON/RF OFF). When the unit is in the Level Step mode of operation, the

annunciator LEVEL STEP is displayed.

The level display also contains annunciators associated with the AutoCal® and the diagnostics supplied with the Model 2520. These annunciators are described in the AutoCal® and diagnostic text in Section 5 of this manual.

Features 29 and 30 are input and output connectors, respectively.

29. MOD IN CONNECTOR

The modulation in connector is a BNC connector to which a 1 volt peak-to-peak external modulation source may be applied.

30. RF OUT CONNECTOR

The RF out connector is a type N connector at which the RF output signal is obtained.

Features 31 and 32 are provided for use with the option package available with the Model 2520.

31. OPTION KEYS

The five (5) blank keys that are present but nonfunctional on the standard Model 2520 provide operator interfaces to the various options available. When an option is installed, its associated key is labeled. Phase and Pulse Modulation documentation is provided in section 7 of this manual. Other option documentation is supplied separate to this manual.

32. PULSE IN

The Pulse In connector is installed in units that have the pulse modulator option. A plug covers this connector hole in the standard Model 2520.

3.4 REAR PANEL DESCRIPTION

Rear panel connectors and switches are shown in Figure 3-2. Each numbered feature is briefly described in the following paragraph with the same number. (Plugs cover openings labeled MOD IN and RF OUT. These are used with options available for the Model 2520.)

1. INTERNAL REFERENCE OUT CONNECTOR

This is the connector at which the 10 MHz square wave internal reference signal may be obtained.

2. EXTERNAL REFERENCE IN

This is the connector at which an external 1 MHz, 5 MHz, or 10 MHz signal (sign or square wave) is applied; used in conjunction with feature 3, the external/internal reference switch.

3. EXTERNAL/INTERNAL REFERENCE SWITCH

During operation using an internal reference source, this switch must be in the "INT" (internal) position; when using an external reference source the switch should be at the appropriate "EXT" position: "EXT 1" for 1 MHz, "EXT 5" for 5 MHz; or "EXT 10" for 10 MHz.

4. GPIB CONNECTOR

This is the connector for GPIB communication. It permits instrument operation from a remote controller (documentation for GPIB operation is in Section 6 of this manual).

5. OPERATE/AutoCal® KEYLOCK SWITCH

During normal operation this keylock switch must be in the "OPERATE" position. The "AutoCal®" position permits access to the user diagnostics supplied with the Model 2520, one of which is the almost completely automatic AutoCal® calibration procedure.

(The calibration procedure is described in Section 5 of this manual.)

6. FAN

The fan removes heat from the instrument. Air inlet vents are located on

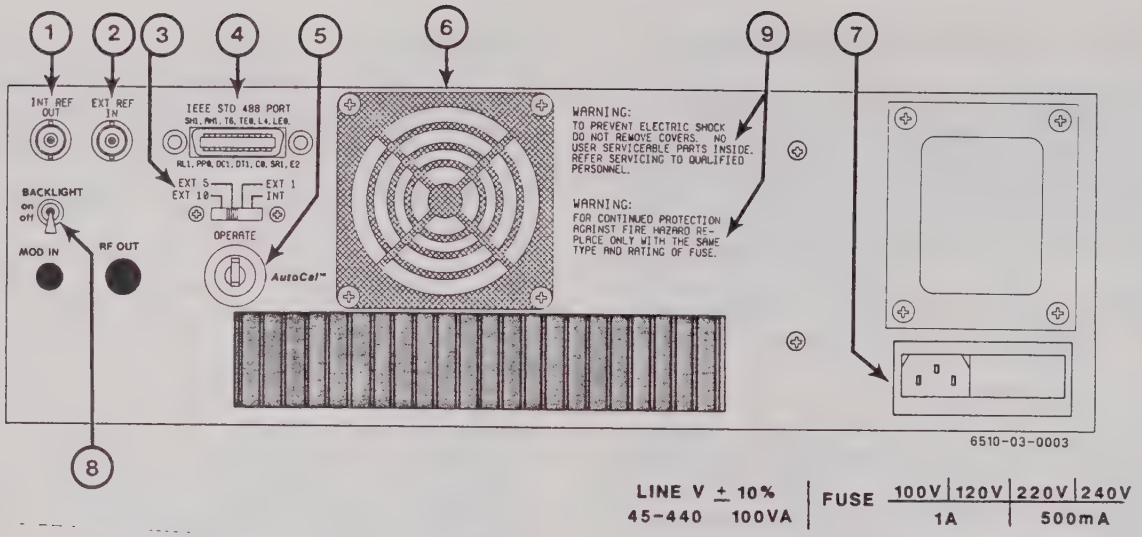

Figure 3-2. Wavetek Model 2520 Rear Panel

the bottom cover near the front of the unit.

7. AC POWER CONNECTOR MODULE

The voltage selector in this module is removable. It must be inserted in the correct AC line voltage position. When inserted in the correct position it adjusts the unit's power supply accordingly. (See Section 2.4 and Figure 2-1 of this manual for greater detail.)

8. BACKLIGHT ON/OFF SWITCH

The Backlight on/off toggle switch turns the front panel display backlighting on and off.

9. REAR PANEL WARNINGS

Please note the electrical shock and fuse replacement warnings on the rear panel. Note also that there are no user serviceable parts inside this unit. Service must be performed by qualified personnel.

3.5 LOCAL MODE OF OPERATION

In the local mode of operation the instrument is controlled from the front panel. The "OPERATE/AutoCal®" rear panel keylock switch must be in the "OPERATE" position. Front panel control involves interaction of the displays, function keys, spin knob, and termination keys. The operator has complete manual control of the instrument from the front panel.

3.5.1 TURN ON

CAUTION

Allow a 2-second time interval between turning power off and on. The fan has a current protection circuit that turns off if excess current is drawn. If the unit is turned off and on too quickly the surge current could cause the protection circuit to disengage power to the fan, resulting in possible damage to the instrument.

Set the EXT/INT switch (see Section 2.5.2). Depress the power switch to turn on the unit. The automatic power up test sequence described in Section 5.5 will be performed. The unit will power up with the RF output off. Turn on the backlighting, if necessary, using the Backlight on/off switch on the rear panel. The front panel settings that were active when the unit was last turned off will be active when the unit is turned on again.

3.5.2 NUMERIC ENTRIES (KEYBOARD AND SPIN KNOB)

The following front panel operations require numeric entry that can be made using the keyboard and/or the spin knob and its associated cursor (← →) keys up/down (↑ ↓) increment keys:

- Setting the output frequency (FREQ)
- Setting the frequency step interval (FREQ STEP)
- Setting the output level (LVL)
- Setting the level step interval (LVL STEP)
- Setting the source and type of modulation (INT AM, INT FM, EXT AM, EXT FM), and its value (% AM or kHz Deviation FM)
- Recall of stored settings

3.5.2.1 SEQUENCE OF OPERATIONS

The keyboard/spin knob sequence and the instrument response to the keyboard/ spin knob sequence for a numeric entry are:

a. Press the function key (FREQ, FREQ STEP, LVL, LVL STEP, INT AM, INT FM, EXT AM, or EXT FM). After the function is selected, the resolution digit for the spin knob will be indicated on the appropriate display for the function selected.

b. If the spin knob/cursor keys (← →)/ increment keys (↑ ↓) are going to be used to determine the numeric value for the selected function, they must be used before the numeric keypad (numbers 0-9, decimal point, and +/- key) is used to enter a number. (Operation of the spin knob and its associated keys is described in detail in Section 3.5.2.2, immediately following this section.)

c. Either use the spin knob/cursor and increment keys to establish the numeric value to be entered (Section 3.5.2.2) or use the numeric keypad to enter the value for the function. The first keypad number entry will appear in the most significant digit (MSD) of the display for the selected function. Dashes will appear in the remaining digit locations and the decimal point will not appear in the display field. Any suffix will be blanked out. Again, after the first number has been entered using the keypad, the spin knob and its associated keys will be deactivated.

d. Enter the numbers to the left of the decimal point (see e, below). As further numbers are entered, they will be placed to the right of the previously entered digit until the last digit position has been reached. When the last position has been reached, further number entries will be ignored.

e. Enter the decimal, as required. When the decimal key is depressed, the decimal point will be placed to the right of the previously entered digit. The decimal point key can be pressed more than once during a single entry, moving the location of the decimal point. Enter the remaining digits.

f. After the complete number has been entered, the operator must enter a terminator. When the correct terminator key has been pressed, the entered number will be adjusted as required to put it into the standard format. If an insufficient number of digits have been entered, for example, then the display will be filled with zeroes and these will be used for the data entry. The correct suffix will also be enabled. The function will be executed with the new data.

g. The following responses will occur for illegal key entries:

- If an illegal terminator key is depressed, the key entry will be ignored.

- Inadvertently pressing another function key during a numeric entry will enable that function. The function for which the numeric entry was being made will be stored at its previous value.

- If a non-numeric function key (discussed in Section 3.5.4) is depressed, the function will be executed without affecting the numeric entry process. After the non-numeric process has been executed, the numeric entry process will be recalled.

- If the entered data is out of the range of the function, the previous value will be restored to the function and displayed.

3.5.2.2 SPIN KNOB/CURSOR (← →) KEY/ INCREMENT (↑ ↓) KEY OPERATION

The SPIN knob in combination with the left and right cursor keys (← →) and the up and down increment keys (↑ ↓) is used to increase or decrease the numeric value of a function. Clockwise rotation of the knob increases the value; counterclockwise rotation decreases the value. Values for output frequency, frequency step interval, output level, output level step interval, internal and external amplitude modulation, and internal and external frequency modulation may be controlled.

a. The ← (left) and → (right) cursor controls are used to select a given digit, the resolution digit, on the chosen function's display. The resolution digit for a particular function can be changed by using the left and right arrow (← →) cursor keys located under the spin knob. The line under the resolution digit will be moved to the left or right to indicate the selected digit. When the LSD (Least significant digit) is reached using the right arrow key, the next depression of the right arrow key will cause a wrap-around to the MSD, (Most significant digit) of the display field. Likewise, when the MSD is reached using the left arrow key, the next depression of the left arrow key will cause a wrap-around to the LSD of the display field. The resolution digit selected for each function controlled by the spin knob will be retained during operation of the 2520 Signal Generator.

b. When the spin knob is turned, the selected resolution digit will increase or decrease. The digits to the left of the resolution digit will be affected by either a carry or a borrow operation and will also increase or decrease, respectively. The digits to the right of the resolution digit will not be affected by spin knob operation. These digits will maintain their previous values during spin knob operation.

Operation of the spin knob/cursor keys permits very coarse control when used with the most significant digit, and very fine control when used with the least significant digit. For example, when the cursor is set to the 10 Hz digit, one turn of the SPIN knob changes frequency by more than 500 Hz.

When the cursor is set to the 100 MHz digit, approximately one-half turn of the SPIN knob changes the frequency from 0.2 to 1100 MHz.

When the upper or lower range limit of a function is reached with the spin knob, the display and the function parameter will stop at that value. Further spinning of the knob in the direction which caused the limit to be reached will not cause any changes of either the display value or the function parameter.

During operation of the spin knob, all error condition indicators will be suspended until the knob has stopped spinning AND the required settling time has been allowed. This includes all UNLEVELED, UNLOCKED conditions, including any error indicators issued to the GPIB.

c. The ↑ (up) and ↓ (down) increment keys are used to increase or decrease the value of a function one increment for the resolution digit selected. For example, if the resolution digit is the "2" in the frequency 1120.00000 MHz then pressing the ↑ increment key will increase the frequency 10 MHz at each press (from 1120 to 1130 to 1140 to 1150 MHz, etc.). Pressing the ↓ key will decrease the value 10 MHz at each press.

The increment keys may be used with any of the functions listed in Section 3.5.2, earlier. The spin knob must be activated to use the increment keys.

When the unit is in the frequency step mode of operation (see Section 3.5.5.2) or in the level step mode of operation (see Section 3.5.5.4) the spin knob will increase or decrease the frequency or level in the programmed step increments. The resolution digit will have no effect on spin knob or increment key operation.

d. At power-up, the spin knob is activated after the SELF CHECK has been completed. The default function is Frequency and will be indicated by the resolution digit being placed in the least significant digit (LSD) of the frequency display. The LSD is the power-up default position for each of the functions controlled by the knob.

The spin knob is activated for a particular function by depressing the appropriate function key. The function selected will be indicated when a small line is placed under the resolution digit in the appropriate display. If a new function is to be controlled (different from that currently controlled by the knob), when the new function key is pressed the line under the resolution digit of the currently controlled function will disappear and the resolution digit will be indicated in the display for the new function.

If a given function key is pressed and a keyboard numeric entry is made inadvertently, the function key must be pressed again to reenable (reactivate) the spin knob.

e. CAUTION: When the spin knob/cursor keys are used to set the output level, care should be exercised not to overdrive a device being tested.

3.5.3 NUMERIC ENTRY (KEYBOARD ONLY); STORAGE/RECALL OF FRONT PANEL SETTINGS

The 2520 contains sixty-four (64) locations in memory for storage of 64 different sets of front panel settings. These locations are identified by a two digit number (01-64). The function keys STR and RCL (items 16 and 17 of Figure 3-1) are used to initiate storage or recall, respectively, of the front panel settings at a given location. The numeric keyboard is used to specify the two digit location. Refer to Sections 3.5.6 to 3.5.6.2 for a detailed discussion of the front panel settings storage and recall.

3.5.4 NON-NUMERIC ENTRY

Several functions do not require a numeric entry. These functions are direct action functions. The desired operation will be executed when the key is depressed. The functions are:

- Internal modulation source (400/1000) selection (MOD FREQ)
- Selection of the CW unmodulated output (MOD OFF)
- Local mode selection (LCL)
- Switching the RF output on and off (RF ON/OFF)
- ADDR and TERM GPIB functions (see Section 3.3, items 4 and 5).

The MOD FREQ and RF ON/OFF functions are controlled by toggle switches. When the key is depressed the function toggles between the two possibilities available (400/1000 Hz and RF ON/OFF, respectively). The RF ON/OFF switch also is used to reset a tripped RF circuit breaker (see Section 3.6.2).

The MOD OFF, LCL, ADDR, and TERM keys select particular functions. When either of these keys is depressed, the function is executed and the appropriate annunciator(s) is displayed.

3.5.5 SETTING RF OUTPUT CHARACTERISTICS (FREQUENCY, LEVEL, MODULATION)

The three basic RF output characteristics are frequency, level, and modulation. Each can be set from the front panel. This section describes the procedures to set each characteristic when the unit is in the Local Mode of operation. GPIB (Remote Mode) operation is described in Section 6 of this manual.

3.5.5.1 FREQUENCY

The output RF frequency of the 2520 is set using the keyboard/spin knob sequence described in Section 3.5.2, Numeric Entries (Keyboard and Spin Knob).

Press the FREQ function key to initiate a change in frequency. Then enter the numeric value using the keyboard or spin knob/control cursors as described in Section 3.5.2.

The legal terminators for numeric entry of frequency are kHz and MHz. Output frequency is shown on the frequency display.

When FM (Frequency Modulation) is selected and a frequency change $\geq$10 kHz is to be made, the 2520 will be momentarily set to the CW mode. After the frequency change has been made and the generator has stabilized, the original FM output will be restored. (A frequency change <10 kHz will not turn off the modulation.) When the spin knob is used to change the frequency, the modulation will not be restored until the spin knob has stopped.

3.5.5.2 FREQUENCY STEP OPERATION

The frequency step mode of operation is most useful when frequency must be changed repeatedly by the same increment (step). When that increment has been programmed, frequency can be increased or decreased that amount using one keystroke.

To program the step, press the FREQ STEP key and then enter the numeric value of the step using the keyboard as described in Section 3.5.2. The FREQ STEP annunciator will be displayed on the frequency display. Use the appropriate terminator key (MHz or kHz) to complete the step entry.

Press the FREQ key to display the output frequency. Any further use of the up/down (↑ ↓) increment keys or the spin knob will increase or decrease the output frequency by the programmed step size. The frequency step size is one of the front panel settings that are saved during power off and restored at power up.

The unit will remain in the frequency step mode of operation as long as the programmed step value is greater than 0 Hz. To deactivate the frequency step mode of operation, the user must program the frequency step to be 0 Hz.

At this time the Level Step and Frequency Step modes should not be used together. The Frequency Step value must be set to 0 when the Level Step mode is used. The Level Step value should be set at 0 when the Frequency Step mode is used.

3.5.5.3 OUTPUT LEVEL

The RF output level of the 2520 is set using the keyboard/spin knob sequence described in Section 3.5.2.

Press the LVL function key to initiate a change in output level. Enter the numeric value for the required output using the keyboard or spin knob and its associated cursor and increment keys (Section 3.5.2). Terminate the entry using the dBm, mV, or µV key. Output level will be shown on the Level display. If output is shown as a voltage level, the most appropriate display units (mV or µV) will be shown. For example if the dBm value corresponds to a voltage level of 707 mV, pressing the µV key will produce a display that shows 707 mV.

While the unit is in the Level setting mode, dBm may be converted to mV or µV by pressing the mV or µV key (and vice versa). When the unit is not in the Level setting mode, the operator can convert dBm to mV or µV by pressing the LVL function key, then pressing the mV or µV key. The conversion from mV or µV to dBm is performed by pressing the LVL key followed by pressing the dBm key.

CAUTION: When the spin knob and its associated keys are used to set the output level, be careful not to overdrive a device being tested.

3.5.5.4 LEVEL STEP OPERATION

The level step mode of operation is most useful when output level must be changed repeatedly by the same increment (step). When that increment has been programmed, level can be increased or decreased that amount using one keystroke.

To program the step, press the LVL STEP key and then enter the numeric value of the step using the keyboard as described in Section 3.5.2. The LEVEL STEP annunciator will be displayed on the level display. Use the appropriate terminator key (mV, µ, or dBm) to complete the step entry.

Press the LVL key to display the output level. Any further use of the up/down (↑ ↓) increment keys or the spin knob will increase or decrease the output level by the programmed step size. The level step size is one of the front panel settings that are saved during power off and restored at power up.

The unit will remain in the level step mode of operation as long as the programmed step value is greater than 0 Hz. To deactivate the level step mode of operation, the user must program the level step to be 0 dB.

At this time the Level Step and Frequency Step modes should not be used together. The Frequency Step value must be set to 0 when the Level Step mode is used. The Level Step value should be set at 0 when the Frequency Step mode is used.

3.5.5.5 MODULATION

The MOD OFF key selects a CW (unmodulated) output.

Modulation of the 2520 RF output signal is set using the keyboard/spin knob sequence described in Section 3.5.2.

There are three basic modes of modulation that may be selected using the function keys. They are:

- AM, Internal or External
- FM, Internal or External
- Complex, AM and FM together

A single form of modulation (AM, internal or external; FM, internal or external) is established by pressing the function key associated with the described form of modulation (INT AM or EXT AM or INT FM or EXT FM). The numeric value for the modulation depth (AM) or deviation (FM) is then set using the keyboard/spin knob (described in Section 3.5.2). The single modulation is executed by pressing the appropriate terminator key (% for AM; kHz for FM).

The following combinations of complex modulation are possible:

- INT AM and EXT FM
- INT FM and EXT AM

The order in which internal and external modulation are entered is not important.

Modulation characteristics will be shown on the Modulation display. Of course the characteristics for the first entry of a modulation combination will be replaced by those for the second modulation when the second is entered.

The operator must choose between internal modulation sources of 400 and 1000 Hz using the MOD FREQ function key (item 10 on Figure 3-1).

To obtain a calibrated output, an external modulating signal of 1 volt peak-to-peak (0.353 RMS) into a 600Ω load must be provided.

NOTE

If the external modulating signal is not 1 volt peak-to-peak, the output will not be a calibrated output.

3.5.6 STORAGE/RECALL OF FRONT PANEL SETTINGS

There are 64 memory locations set aside for storage of 64 complete front panel settings (output frequency, level, and modulation settings). The function keys associated with this dedicated memory are the STR (store) and RCL (recall) keys. The spin knob and the up/down (↑ ↓) increment keys may be used with this function. Each is described below.

3.5.6.1 TO STORE A SETTING

To store the current front panel settings, the following key sequence is used.

1) Press the STR function key. The words "LOCATION STORED" will appear on the Frequency display. The last location into which front panel settings were stored also will be displayed.

2) Enter the two digit number that designates the storage location. Location 3 would be entered as "0" and "3". When the second digit is entered, the current front panel settings are stored at that location.

3.5.6.2 TO RECALL A STORED SETTING

To recall a stored setting, the following key sequence is used.

1) Press the RCL function key. The words "LOCATION RECALLED" will appear on the Frequency display. The last location from which front panel settings were recalled will be indicated on the display.

2) Enter the two digit number identifying the location from which recall is to be performed. After the second digit is entered, the front panel settings that were recalled will be executed by the 2520 and the Modulation, Frequency, and Level displays will be updated to show the recalled settings. The Frequency display will retain the "LOCATION RECALLED" annunciator and the number of the location as long as the recalled front panel settings are used.

3) If a location that has not been programmed is recalled, the display will show "NO STORED SETTING RECALLED" (see Section 3.5.6.5).

3.5.6.3 UP/DOWN (↑ ↓) INCREMENT KEYS

After the RCL key has been pushed, the spin knob or the up/down (↑ ↓) increment keys may be used to recall the complete setting from the next memory location. All displays will be updated with each recall. Location addresses will wrap around from location "64" to location "01" and from location "01" to location "64" (if the ↓ is used).

3.5.6.4 EXITING THE STR/RCL OPERATION

To exit the STR/RCL operation, select any other function. The annunciator NO STORED SETTING RECALLED will be shown on the frequency display.

3.5.6.5 NO STORED SETTING RECALLED

When the unit is not operating by front panel settings recalled from one of the 64 memory locations, the Frequency display will show the annunciator NO STORED SETTING RECALLED. No memory location number will be shown. An attempt to recall settings from a location where none have been entered or where the memory element itself is physically defective will result in the NO STORED SETTING RECALLED indicator.

3.5.6.6 ILLEGAL KEY ENTRY RESPONSES

The following responses will occur for illegal key entries:

1) If a terminator, sign, or decimal point key is depressed, the key will be ignored.

2) If any function key associated with a numeric entry is pressed, then that function is enabled and the frequency is displayed.

3) If a function key not associated with a numeric entry is pressed, the function will be executed. After the non-numeric process has been executed, the storage/recall process will be re-entered.

4) If the stored setting number is out of range, the entry is ignored. The display returns to that shown when awaiting the stored or recalled setting number.

3.5.7 RETURN TO LOCAL MODE OF OPERATION FROM REMOTE (GPIB)

The LCL key will cause the 2520 to exit the Remote Mode (GPIB) of operation and return to full front panel operation (Local Mode).

When the unit is in the Remote Mode, the REMOTE indicator is shown on the Modulation display. The front panel keys (except for LCL and SRQ) and the spin knob are disabled. The LCL key is disabled if the local lockout command is received over the GPIB. The SRQ key is used only during GPIB operation. (GPIB operation is described in Section 6 of this manual.)

3.6 OPERATOR ERROR MESSAGES

The Model 2520 is the easiest to operate RF signal generator in its class. Nevertheless there are several types of operator error possible with this instrument. Operation of the instrument outside its specified range may generate one or more of the following front panel display messages.

3.6.1 UNLOCKED (on FREQUENCY display)

An "UNLOCKED" message on the FREQUENCY display may indicate that the EXTERNAL/INTERNAL REFERENCE SELECT SWITCH on the rear panel (item 3 of Figure 3-2) has been accidentally placed in the wrong position. Check this switch if the unlocked message occurs. (The UNLOCKED message also may indicate a calibration is due -- see Section 3.7.)

3.6.2 TRIPPED (on LEVEL display)

A "TRIPPED" message on the LEVEL display indicates the reverse power protection circuitry has been activated, tripping the RF circuit breaker. If this occurs, correct the problem causing the tripped condition. Turn the RF ON/OFF switch to off, then back on to reset the circuit breaker.

Inadvertently connecting an external input to the RF output may trip the RF circuit breaker.

3.6.3 FM OVERMOD ANNUNCIATOR

The FM OVERMOD annunciator on the MODULATION display indicates that the operator has over modulated the RF

output, saturating the phase detector in the phase lock circuit. Maximum allowable FM deviation (ΔF_{max}) before overmodulation may occur is a function of modulation rate (f_m) and carrier frequency (f_o). The relationship is approximated by:

$\Delta F_{max} = 4 (f_m) (f_o)$; for $f_o > 137.5$ MHz

$\Delta F_{max} = 4 (f_m) (500 - f_o)$; for $f_o < 137.5$ MHz

For the above equations, f_o must be in units of MHz; F_{max} and f_m may be in Hz, kHz, etc., but both must have the same units.

Modulation rate and carrier frequency determine the maximum FM deviation that may be applied before overmodulation may occur. For example, with a carrier frequency of 300 MHz and a deviation rate of 400 Hz, the maximum FM modulation that may be used is:

$\Delta F_{max} = 4$ (400 Hz) (300)

= (1600 Hz) (300)

= 480,000 Hz = 480 kHz

If an operator attempts to apply 500 kHz FM the over modulation indication may occur. The operator must reduce the deviation until the FM OVERMOD annunciator turns off. Changes in the carrier frequency and/or modulation rate may be made to change the amount of FM modulation possible.

If the spin knob is used to set a permitted modulation (less than or equal to ΔF_{max}), over modulation may occur if the operator overshoots the desired value. Because of hysteresis in the system, reducing the modulation below the desired value will be necessary to erase the over modulation indicator. The operator also may set modulation at the desired level and then turn off the modulation and then turn it on again.

3.7 CALIBRATION DUE INDICATORS

There are two front panel display messages that may indicate the 2520 is out of calibration.

3.7.1 UNLOCKED (on FREQUENCY display)

The "UNLOCKED" message on the FREQUENCY display may indicate the phase locked loop in the output frequency generating circuitry has become unlocked. If the "UNLOCKED" message occurs the operator should first verify the EXTERNAL/ INTERNAL REFERENCE SELECT switch is set properly (see Section 3.6.1). If it is set properly, the operator should perform the calibration described in Section 5.3 of this manual. (If this procedure does not erase the UNLOCKED indicator, the unit has a problem that will require troubleshooting. Wavetek offers an optional Service Manual that includes information useful to troubleshoot/repair the Model 2520. Wavetek recommends returning the unit to the factory for repair, after factory authorization, unless the customer has highly qualified maintenance personnel that are experienced at RF repair work.)

3.7.2 UNLVD (on LEVEL display)

The UNLVD message may indicate the output amplifier/leveling circuitry is out of calibration. The operator should perform the calibration described in Section 5.3 of this manual. (If this procedure does not erase the UNLVD message, the unit has a problem that will require troubleshooting. Wavetek offers an optional Service Manual that includes information useful to troubleshoot/repair the Model 2520. Wavetek recommends returning the unit to the factory for repair, after factory authorization, unless the customer has highly qualified maintenance personnel that are experienced at RF repair work.)

SECTION 4

PERFORMANCE TESTS

4.1 INTRODUCTION

This section contains the performance tests to verify that the Wavetek Model 2520 RF Signal Generator meets its published specifications (Section 1.2).

These tests will be performed with the unit in the Local Mode of operation (GPIB testing is described in Section 6 of this manual.)

Individual performance tests consist of: the specification to be verified; the method of testing; the test equipment required; and a detailed test procedure.

If a performance test cannot be completed satisfactorily the AutoCal® procedure of Section 5 should be performed and the test repeated. If the test is failed again, after auto calibration, the field calibration detailed in section 5.5 may be performed. If that does not solve the problem, Wavetek recommends that the unit be returned to the factory for factory recalibration and/or repair, after authorization from the factory. A Model 2520 Service Manual may be purchased from Wavetek for troubleshooting purposes. The Service Manual contains the Theory of Operation for the unit, a generalized troubleshooting guide, reference drawings, and replaceable parts lists.

The Customer Service Department at the factory is available for consultation during the regular work week.

Recommended test equipment is listed in Table 4-1. Test equipment required for each procedure is identified in each procedure by number(s) from Table 4-1.

The Model 2520 Signal Generator should have its top and bottom covers installed for the performance tests. All of the tests can be performed without access to the internal controls. Before applying power to the Signal Generator, see Section 2 for details of electrical installation. The line voltage should be maintained as specified in Section 2.4 throughout the tests. Allow a one-hour warm up of the Signal Generator before beginning the performance test procedures.

A copy of a sample Performance Test Record (PTR) is provided at the end of this section. Record the performance of the Signal Generator during performance tests on this or a similar form. It can be filled out and used as a permanent record for incoming inspection, or it can be used as a guide for routine performance testing. The PTR lists the section, test, and specification limits. All tests refer to this record.

TABLE 4-1. RECOMMENDED TEST EQUIPMENT

	INSTRUMENT	RECOMMENDED
(1)	Signal Generator	Wavetek Model 2500 or equivalent
(2)	Oscilloscope	Tektronix 465 or equivalent, with matched X10 probes
(3)	Frequency Counter	Hewlett-Packard Model 5350A (HP5350A) with external reference time base accuracy of ±5 parts in 10^8, or equivalent
(4)	DVM	Fluke Model 8012A, or equivalent
(5)	Spectrum Analyzer	Tektronix 492, 492P, or equivalent
(6)	Spectrum Analyzer	HP8568B, or equivalent
(7)	Modulation Analyzer	Boonton 8200, with option to 2200 MHz; or HP8901A, used with a mixer and another signal generator (Wavetek Model 2520) to down convert tested signal into HP8901A range
(8)	Measuring Receiver	HP8902A, with sensor module 11722A, or equivalent
(9a)	Power Meter	HP436A, with Power Sensor 8484A, or equivalent
(9b)	Power Meter	HP436A, with Power Sensor 8482A, or equivalent
(10)	Function Generator	Wavetek Model 20 or equivalent
(11)	Audio Analyzer	HP8903A, or equivalent
(12)	VSWR Bridge	Wiltron Model 60N50, or equivalent
(13)	Sweep Generator	Wavetek Model 2002B, or equivalent

4.2 FREQUENCY RESOLUTION AND RANGE TEST

SPECIFICATION	MIN FREQ	MAX FREQ	RESOLUTION
	.2 MHz	2200 MHz	10 Hz < 1100 MHz 20 Hz > 1100 MHz

METHOD

A frequency counter is used to measure frequency resolution and range. The spin knob and its associated cursor/increment keys (see Section 3.5.2.2) are used to step through the frequency range to verify spin knob/cursor and increment key operation. Frequency resolution may be varied from 10 Hz to 1000 MHz, depending upon which digit is established as the resolution digit.

EQUIPMENT (3)

PROCEDURE

1. Put the unit into the Local Mode of operation. Connect the Model 2520 front-panel RF OUT connector to the appropriate input of the frequency counter. Use the MOD OFF key to select a CW output. Turn on the RF output.

2. Use the spin knob and cursor keys to step through each frequency range shown in the following table. The underlined digit in each range is the resolution digit for that range. The value of the resolution digit will be increased one step (one unit) at a time until the entire range is verified. The Model 2520 resolution per step in each range is indicated below. Read the frequency counter after each step change. Verify the counter shows the same frequency as that set on the Model 2520, to within the specified accuracies of the counter and the 2520. Record the frequency counter values for minimum (.2 MHz) and maximum (2200 MHz) frequencies.

FREQUENCY RANGES (MHz)	2520 RESOLUTION
0.20000 - 0.20010	10 Hz
0.20010 - 0.20100	100 Hz
0.20100 - 0.21000	1 kHz
0.21000 - 0.30000	10 kHz
0.30000 - 1.00000	100 kHz
1.00000 - 10.00000	1 MHz
10.00000 - 100.00000	10 MHz
100.00000 - 1000.00000	100 MHz
1000.00000 - 2000.00000	1000 MHz

3. Use the numeric keypad (see Section 3.4.2.1, if necessary) to enter a frequency output of 0.2 MHz. The frequency counter should indicate a value between 199.9995 kHz and 200.0005 kHz. Use the numeric keypad to enter a frequency output of 2200 MHz. The frequency counter should indicate a value between 2,199,994.500 kHz and 2,200,005.500 kHz.

4. Verify that the frequency counter values recorded in step 2, above, for .2 MHz and 2200 MHz outputs are within 199.9995 kHz to 200.0005 kHz and 2,199,994.500 kHz to 2,200,005.500 kHz, respectively.

4.3 FREQUENCY ACCURACY TEST

SPECIFICATION

All modes (CW, AM, and FM):
±2.5 ppm (±.00025%), 0 - 50° C

METHOD

A frequency counter is used to measure frequency accuracy. All carrier frequencies are derived from a single temperature compensated crystal-controlled oscillator (TCXO). The instrument will be tested at 500 MHz (CW) to verify that the crystal-controlled oscillator operates within specified limits. The user may pick a frequency value in each of the five frequency ranges to verify the Model 2520 frequency conversion circuitry.

EQUIPMENT

(3)

PROCEDURE

1. Set the 2520 CW output at 500 MHz. Use the frequency counter to verify the frequency output is between 499,998.750 kHz (499.998750 MHz) and 500,001.250 kHz (500.001250 MHz).

2. Set the 2520 CW output for a value between .2 MHz and 137.5 MHz. Record the chosen value. Use the frequency counter to verify that the frequency output is within ±.00025% of that value. For example, if the 2520 output is set at 70 MHz the frequency counter should read between 69,999.825 kHz (69.999825 MHz) and 70,000.175 kHz (70.000175 MHz).

3. Set the 2520 CW output for a value between 137.5 MHz and 275 MHz. Record the chosen value. Use the frequency counter to verify that the frequency output is within ±.00025% of the chosen value.

4. Set the CW output for a value between 275 MHz and 550 MHz. Record the chosen value. Use the frequency counter to verify that the frequency output is within ±.00025% of that value.

5. Set the CW output for a value between 550 MHz and 1100 MHz. Record the value. Use the frequency counter to verify the output frequency is within ±.00025% of the chosen frequency.

6. Set the CW output for a value between 1100 MHz and 2200 MHz. Record the value. Use the frequency counter to verify the output frequency is within ±.00025% of the chosen frequency.

4.4 HARMONICS TEST

SPECIFICATION

<-25 dBc from 0.2 MHz to <0.4 MHz
<-30 dBc from 0.4 MHz to <1100 MHz
<-25 dBc for >1100 MHz

METHOD

A spectrum analyzer is used to determine levels for the second and third harmonics associated with the output frequency range of the Model 2520.

EQUIPMENT (5)

PROCEDURE

1. Set the 2520 output for .2 MHz frequency at a +13 dBm level.

2. Connect the spectrum analyzer. Use the spin knob/ cursor keys (see Section 3.5.2.2, if necessary) to establish the 10 kHz digit (0.20000) as the resolution digit and then increase the frequency from 0.2 MHz to 0.4 MHz in 10 kHz steps. Monitor the second and third harmonics on the analyzer at each step. Record the worst case. It should be less than -25 dBc.

3. Increase the output frequency from 0.4 MHz to 10 MHz in 10 kHz steps. Set the resolution digit at 1 MHz (10.00000 MHz) and increase the output frequency from 10 MHz to 2200 MHz in 1 MHz steps. Monitor the second and third harmonics at each step. Record the worst case. It should be less than -30 dBc for frequencies <1100 MHz and <-25 dBc for frequencies >1100 MHz.

4. Set the 2520 output level at +3 dBm and repeat steps #2 and #3, described above.

5. Set the 2520 output level at -7 dBm and repeat steps #2 and #3, described above.

4.5 NON-HARMONICS TEST

SPECIFICATION

Offset >5 kHz from carrier frequency:
<-50 dBc for carrier frequencies <137.5 MHz
<-60 dBc for carrier frequencies from 137.5 MHz to 1100 MHz
<-54 dBc for carrier frequencies >1100 MHz

Offset 500 kHz to 5 kHz from carrier frequency:
<-50 dBc, typically, in all frequency ranges

METHOD A spectrum analyzer is used to measure non-harmonics at -7 dBm and 0 dBm output levels.

EQUIPMENT (5)

PROCEDURE

1. Set the 2520 for a 50 MHz output signal at a -7 dBm level. Set the spectrum analyzer for a 50 - 550 MHz sweep.

2. Use the spin knob/cursor keys (Section 3.4.2.2) to increase frequency in 0.1 MHz steps from 50 MHz to 137.5 MHz. Check each step for non-harmonics. Record the location (frequency) and level for the worst case.

3. Set the 2520 for a 551.26 MHz output signal at a 0 dBm level. Set the spectrum analyzer for a 100 kHz/division sweep width centered at 551.26 MHz. Record the worst case sideband level and location.

4. Repeat step 3 with the 2520 output set at each of the frequencies shown below and spectrum analyzer centered at each of the frequencies shown below. Record the worst case sideband level and location for each frequency.

a. 653.26 MHz
b. 655.26 MHz
c. 777.26 MHz
d. 781.26 MHz
e. 925.26 MHz
f. 926.26 MHz
g. 1099.26 MHz

5. Repeat step 3 with the 2520 output set at each of the frequencies shown below and spectrum analyzer centered at each of the frequencies shown below. Record the worst case sideband level and location for each frequency.

a. 1102.52 MHz
b. 1306.52 MHz
c. 1310.52 MHz
d. 1554.52 MHz
e. 1562.52 MHz
f. 1850.52 MHz
g. 1852.52 MHz
h. 2198.52 MHz

4.6 SUB-HARMONICS TEST

SPECIFICATION

-25 dBc for frequencies >550 MHz.

METHOD

A spectrum analyzer is used to measure sub-harmonics at +13 and -7 dBm output levels in the frequency range from 551 to 2200 MHz.

EQUIPMENT

(5)

PROCEDURE

1. Set the 2520 at a 551 MHz output frequency (fo = 551 MHz) and a +13 dBm power level. Use the spectrum analyzer to check sub-harmonic levels at 1/2 the carrier frequency (1/2 fo = 275.5 MHz) and 3/2 the carrier frequency (3/2 fo = 826.5 MHz). Record the sub-harmonic levels.

2. Use the 2520 spin knob to increase the output frequency to 2200 MHz, carefully monitoring 1/2 fo and 3/2 fo as the output frequency increases. The

sub-harmonic frequencies in MHz for each 60 MHz value from 560 MHz are shown below.

fo	1/2 fo	3/2 fo
560	280	840
620	310	930
680	355	1020
740	370	1110
800	400	1200
860	430	1290
920	460	1380
980	490	1470
1040	520	1560
1100	550	1650
1160	580	1740
1220	610	1830
1280	640	1920
1340	670	2010
1400	700	2100
1460	730	2190
1520	760	2280
1580	790	2370
1640	820	2460
1700	850	2550
1760	880	2640
1820	910	2730
1880	940	2820
1940	970	2910
2000	1000	3000
2060	1030	3090
2120	1060	3180
2180	1090	3270

Record the worst case sub-harmonics level(s) and location(s).

3. Repeat step 1, above, with the 2520 output level set at -7 dBm.

4. Repeat step 2, above, with the 2520 output level set at -7 dBm.

4.7 PHASE NOISE TEST

SPECIFICATION

<-107 dBc/Hz at 500 MHz; 10 kHz offset from carrier frequency

METHOD

A spectrum analyzer is used to measure phase noise at 500 MHz.

EQUIPMENT

(6)

PROCEDURE

1. Set the 2520 output to a frequency of 500 MHz and a 0 dBm level, with no modulation. Connect the spectrum analyzer. Center the analyzer at 500 MHz.

2. Set the analyzer at the following values:

50 kHz span
1 kHz resolution BW
30 Hz video BW
0 dBm reference level

3. Press the following analyzer key sequence to reference the 2520 output signal to the graticule of the analyzer CRT display:

a. "Peak search"
b. "Mkr→Ref level"
c. "Signal track"
d. "OFF"

4. Press the following analyzer key sequence to measure phase noise in a 1 Hz BW:

a. "Shift"
b. "Normal" (Marker)
c. "↑"
d. "↑" (again)

5. Read the phase noise value directly from the analyzer CRT display. It should be more than 107 dB below the reference level (shown at the top of the display).

4.8 SWITCHING SPEED TEST

SPECIFICATION

200 mSec, Maximum (Typically 100 mSec)

METHOD

A spectrum analyzer will be used to measure switching speed over two frequency changes.

EQUIPMENT

(6)

PROCEDURE

1. Set the 2520 for a 550 MHz output at a 0 dBm level, with no modulation.

2. Set the spectrum analyzer at the following values, then connect the 2520:

a. 550.5 MHz center frequency
b. 0 dBm reference level
c. 300 kHz resolution BW
d. 100 kHz video BW
e. 0 Hz span
f. 1 Sec sweep time

3. The spectrum analyzer CRT display will be used to indicate switching speed as the 2520 changes frequency from 550 MHz to 550.1 MHz and back again. The frequency change must begin at the same time as an analyzer trace (sweep) begins (step 4, below). The "VIEW" key on the analyzer must be pushed before the end of the same sweep (step 5, below).

4. Use the 2520 numeric keypad sequence (Section 3.4.2.1) to select a frequency change (press "FREQ" key), then enter a frequency value of 550.1 (press the appropriate numeric/decimal keys), and finally enter the terminator (press "MHz" key) at the beginning of a CRT sweep.

5. Push the "VIEW" key before the end of the sweep at which the 2520 "MHz" terminator key was pushed (step 4). Performing step 4 and this step requires use of both hands, one for the 2520 and one for the analyzer.

6. Note the transient character of the "stored" analyzer sweep. The trace should have settled (returned to reference level) in less than 2 horizontal screen divisions (200 mSec).

7. Push the appropriate key on the spectrum analyzer to clear the stored CRT display.

8. Repeat step 4 above, except enter a 2520 frequency of 550 MHz.

9. Repeat steps 5 - 7, above.

10. Set the 2520 for a 389 MHz output. Set the analyzer at a center frequency of 389.1 MHz. (The remaining values are set as shown in steps 1 and 2, above.)

11. Repeat step 4, above, except set the 2520 at a 389.1 MHz output.

12. Repeat steps 5 - 7, above.

13. Repeat step 4, above, except set the 2520 at a 389 MHz output.

14. Repeat steps 5 - 7, above.

15. Disconnect the spectrum analyzer.

4.9 AM PERFORMANCE TESTS

SPECIFICATION

AM Accuracy	±(2% + 6% of setting); 0.2 MHz to <1 MHz (0 - 90%)±(2% + 4% of setting); 1 MHz to <1100 MHz ±(2% + 6% of setting); 1100 MHz to <2200 MHz
Distortion (at 1 kHz rate)	at 90% AM = <5% at 70% AM = <3% at 30% AM = <1.5%
Frequency Response	DC to 15 kHz: (0 to 50% AM)

METHOD

An audio analyzer and a modulation analyzer or a measuring receiver will be used to measure AM accuracy and distortion at three modulation levels for +3 dBm and −7 dBm output levels. A function generator will then be used to help measure frequency response (AM bandwidth) over an external 1 kHz to 15 kHz modulation rate at 50% AM.

EQUIPMENT

(7) and (11) and (10)

PROCEDURE

1. There are a variety of modulation analyzers and measuring receivers on the market that measure AM accuracy and distortion. Some audio analyzers also contain an audio generator. The user must modify the following procedure according to the equipment available.

2. Make the following connections, as appropriate. Connect the 2520 output to the modulation analyzer. Connect the audio output of the modulation analyzer to the audio analyzer input. Connect the function generator output to the external modulation input of the 2520.

3. AM accuracy and distortion will be measured together at the modulation and power levels identified below. AM frequency response (bandwidth) will be tested later in this procedure (starting with step 15 below).

4. Set the 2520 for an output frequency of 11 MHz, internal AM, and modulation at the 1 kHz rate. Set the output power level at +3 dBm. Set AM for 90%.

5. Press the "+PK and "-PK" control buttons on the modulation analyzer and record modulation accuracy. Calculate average accuracy as: $\frac{(+PK) + (-PK)}{2}$ and record this value. Verify it is within 84.4% to 95.6%, the specified ±(2% + 4% of setting) range.

6. Press the appropriate button(s) on the audio analyzer to measure AM distortion. Record the displayed value (or record the distortion value determined using the modulation meter, if appropriate). Distortion must be less than 5%.

7. Repeat steps 5 and 6 for each of the following frequencies from 1 MHz to less than 1100 MHz:

a. 137 MHz
b. 138 MHz
c. 194 MHz
d. 195 MHz
e. 274 MHz
f. 275 MHz
g. 400 MHz
h. 550 MHz
i. 551 MHz
j. 620 MHz
k. 692 MHz
l. 693 MHz
m. 780 MHz
n. 872 MHz
o. 873 MHz
p. 1000 MHz
q. 1090 MHz

Repeat steps 5 and 6 for each of the following frequencies greater than 1100 MHz. Calculate the specified value as ±(2% + 6% of setting). For example, 90% AM at 1240 MHz is 90% ±(2% + 6% of 90%), or 90% ±(2% + 5.4%), which is 90% ±7.4%, for an acceptable range of 82.6% to 97.4%.

r. 1100 MHz
s. 1240 MHz
t. 1384 MHz
u. 1386 MHz
v. 1560 MHz
w. 1744 MHz
x. 1746 MHz
y. 2000 MHz
z. 2200 MHz

8. Set the 2520 AM level to 70% and the output frequency to 11 MHz. Repeat step 5, above. The average accuracy must be within 65.2 - 74.8%, the specified 70% ±(2% + 4% of setting) range.

9. Repeat step 6, above, distortion must be less than 3%.

10. Repeat steps 8 and 9, above, for each of the frequencies listed in step 7, above.

11. Set the 2520 for a 30% AM level and 11 MHz frequency output. Repeat step 5. AM accuracy must be within 26.8 - 33.2%, which is 30% ±(2% + 4% of setting).

12. Repeat step 6. Distortion must be less than 1.5%.

13. Repeat steps 11 and 12 for each frequency listed in step 7, above.

14. Repeat steps 4 - 13, above, with the 2520 power output set at the -7 dBm level.

15. To measure frequency response (AM bandwidth), set the 2520 for external AM at a 50% modulation level. Set the output frequency at 11 MHz and power at +3 dBm. Set the function generator for a 1 volt peak-to-peak signal at 1 kHz (at the External Modulation Input on the 2520 front panel). Set the modution meter as follows:

a. Push the AM modulation button.
b. Press the "±" button.
c. Set the modulation detectors for a dB indication. Verify the modulation display shows ~ 0 dB.

16. Use the function generator to sweep from 1 kHz to 15 kHz. Observe the relative dB output change on the modulation meter. Record the change. It should be less than 3 dB.

17. Repeat steps 15 and 16 for each of the frequencies listed in step 7.

4.10 RESIDUAL AM TEST

SPECIFICATION

<-65 dBc; CW mode with 50 Hz to 15 kHz post detection bandwidth (PDBW)

METHOD

A modulation analyzer is used to measure residual AM at a variety of output frequencies.

EQUIPMENT

(7)

PROCEDURE

1. Set the 2520 for a 200 kHz output at the 0 dBm level with no modulation.

2. Connect the 2520 output to the analyzer. Select the 50 Hz high pass and 15 kHz low pass post detection bandwidth filters on the modulation analyzer.

Put the analyzer in the average detection mode.

3. Record the residual AM measurement. It should be <-65 dBc.

4. Change the 2520 frequency output to each of the frequencies listed below and record the residual AM associated with each. Each should be <-65 dBc.

a. 1 MHz
b. 100 MHz
c. 1090 MHz
d. 1100 MHz
e. 2200 MHz

4.11 RESIDUAL FM TEST

SPECIFICATION

Post detection bandwidth .05 - 15 kHz
< 30 Hz rms (.2 - 137.5 MHz)
< 10 Hz rms (137.5 - 275 MHz)
< 20 Hz rms (275 - 550 MHz)
< 40 Hz rms (550 - 1100 MHz)
< 80 Hz rms (>1100 MHz)

Post detection bandwidth .3 - 3 kHz
< 15 Hz rms (.2 - 137.5 MHz)
< 7 Hz rms (137.5 - 275 MHz)
< 10 Hz rms (275 - 550 MHz)
< 20 Hz rms (550 - 1100 MHz)
< 40 Hz rms (>1100 MHz)

METHOD

A measuring receiver is used to measure residual FM at selected frequencies from 100.001 MHz to 550 MHz.

EQUIPMENT

(8)

PROCEDURE

1. Set the 2520 for a 100.001 MHz output at the 0 dBm level with no modulation.

2. Connect the 2520 output to an HP8902A measuring receiver, or equivalent. Select the 50 Hz high pass and 15 kHz low pass post detection bandwidth filters on the measuring receiver. Put the receiver in the average detection mode.

3. Record the residual FM measurement. It should be less than 30 Hz rms.

4. Change the 2520 frequency output to each of the frequencies listed below and record the residual FM associated with each. Each should be less than the specification shown above.

a. 125.001 MHz
b. 275 MHz
c. 325 MHz
d. 330 MHz
e. 389 MHz
f. 390 MHz
g. 463 MHz
h. 464 MHz
i. 550 MHz

5. The user may elect to choose and then determine residual FM values associated with 2520 frequency outputs in each of the ranges shown in the specification for residual FM.

6. The user may elect to set up the measuring receiver to test post detection bandwidth of .3 - 3 kHz and repeat steps 1 - 5, above.

4.12 FM PERFORMANCE TESTS

SPECIFICATIONS

FM Accuracy	±6% of setting, at internal rates (excluding residual FM)
Distortion	<2% at internal rates for deviation <100 kHz
FM Bandwidth	20 Hz to 100 kHz (0 kHz to 100 kHz with FSK option)
Deviation Range	For 1 kHz rate: 1 MHz peak for 3 - 137.5 MHz and 275 - 1100 MHz 500 kHz peak for 137.5 - 275 MHz 1.999 MHz peak for >1100 MHz

METHOD

A modulation analyzer is used to measure FM accuracy. An audio analyzer and a modulation analyzer are used to measure FM distortion. A function generator and modulation analyzer are used to measure the FM bandwidth. The frequency deviation range is measured using a spectrum analyzer.

EQUIPMENT

(7) or (8); (10); (11); (5)

PROCEDURE

1. There are a variety of modulation analyzers on the market that measure FM accuracy and distortion. Some audio analyzers also contain an audio generator. The user must modify the following procedure according to the equipment available.

2. Make the following connections, as appropriate. Connect the 2520 RF output to the modulation analyzer. Connect the audio output of the modulation analyzer to the input of the audio analyzer.

3. To determine FM accuracy, set the 2520 for an output frequency of 275 MHz at the 0 dBm power level. Select the internal 1 kHz modulation source. Set internal FM deviation at 99.9 kHz. Read deviation accuracy on the modulation analyzer (+PK value) and verify it is between 93.9 kHz and 105.9 kHz.

4. Repeat step 3, increasing the 2520 output frequency from 275 MHz to 550 MHz in 5 MHz steps. Verify FM deviation shown on the modulation analyzer is between 93.9 kHz and 105.9 kHz at each frequency. Record the worst case deviation.

5. To further check FM accuracy and to check FM distortion, set the 2520 output frequency to 500 MHz. Record the FM accuracy reading (+PK) on the modulation analyzer. It must be between 93.9 and 105.9 kHz (±6% of setting). Set the modulation analyzer to measure FM distortion and record the value shown. Distortion must be less than 2%.

6. Set FM deviation at 100.0 kHz. Measure FM accuracy and distortion. Accuracy as shown on the modulation analyzer must be between 94 kHz and 106 kHz. Distortion must be <2%.

7. Change the 2520 internal modulation source from the 1 kHz to the 400 Hz source. Set FM deviation at 99.9 kHz. Record FM accuracy and distortion. Verify accuracy is between 93.9 kHz and 105.9 kHz and distortion is less than 2%.

8. Set FM deviation at 100.0 kHz. Record accuracy and distortion. Verify accuracy is between 94 kHz and 106 kHz. Verify distortion is less than 2%.

9. To measure FM bandwidth set the 2520 for external FM at 9.9 kHz deviation. Set the output frequency at 330 MHz.

10. Use the function generator to apply a 1 Vpp signal at a 1 kHz rate to the 2520.

11. Set the modulation analyzer for "average" detection. Use the Rel dB function on the analyzer to set the modulation reference rate at 1 kHz.

12. Use the function generator to sweep from 20 Hz to 100 kHz while observing the relative dB output change on the analyzer. Record the change. It should be ±3 dB or less.

13. Disconnect the test equipment. To measure deviation range connect the 2520 RF output to a

spectrum analyzer. Set the 2520 at the 1 kHz internal rate source, at an FM deviation of 1000 kHz, and an output frequency of 389 MHz. Use the spectrum analyzer to verify a deviation range of 1 MHz ±6% (2 MHz peak to peak).

14. Select an output frequency value between 137 to 275 MHz. Repeat step 13. Verify the 500 kHz peak deviation range on the spectrum analyzer.

15. Select an output frequency between 1100 and 2200 MHz. Repeat step 13. Verify the 1.999 MHz peak deviation range on the spectrum analyzer.

16. Disconnect the spectrum analyzer.

4.13 OUTPUT POWER ACCURACY TEST

SPECIFICATION

±1.5 dB for levels >-37 dBm
±1.5 + (0.1/10 dB step decrease) dB for power levels <-37 dBm and frequencies <1100 MHz
±1.5 + (0.2/10 dB step decrease) dB for power levels <-37 dBm and frequencies >1100 MHz

METHOD

A measuring receiver with power sensor is used to measure output power at 3 representative frequencies below 1300 MHz. A power meter is used to measure output power at 2200 MHz.

EQUIPMENT

(8); (9a)

PROCEDURE

1. Connect the 2520 RF output to the power sensor for the measuring receiver. Set the 2520 for an output frequency of 5 MHz at a +13 dBm power level.

2. Read the power measurement on the measuring receiver and verify it is between +14.5 and +11.5 dBm.

3. Set output power to 0 dBm and verify the measuring receiver reading is between -1.50 and +1.50 dBm.

4. Use the cursor keys to set the output power resolution digit at the 10 dB incremental position and turn the spin knob counterclockwise or use the increment key to decrease output power in 10 dB steps. Observe the output level on the measuring receiver and verify it is within the range associated with each output level setting below:

Output (dBm)	Range (dBm)
-10	-11.50 to -8.50
-20	-21.50 to -18.50
-30	-31.50 to -28.50

Output (dBm)	Range (dBm)
-40	-41.60 to -38.40
-50	-51.70 to -48.30
-60	-61.80 to -58.20
-70	-71.90 to -68.10
-80	-82.00 to -78.00
-90	-92.10 to -87.90
-100	-102.20 to -97.80
-110	-112.30 to -107.70
-120	-122.40 to -117.60
-130	-132.50 to -127.50

5. Set the 2520 output frequency to 400 MHz. Set the power level at +13 dBm. Repeat step 2, above.

6. Repeat step 3, above.

7. Repeat step 4, above.

8. Set the 2520 output frequency to 1090 MHz. Set the power level at +13 dBm. Repeat step 2, above.

9. Repeat step 3, above.

10. Repeat step 4, above.

11. The user may elect to set the 2520 at a frequency between 1100 MHz and 1300 MHz and perform steps 2 - 4 again. Note that at frequencies greater than 1100 MHz, the range limits for output power is the programmed value ±1.5 +(0.2/10 dB step decrease) dB for programmed power levels <-37 dBm. The output range for a programmed value of -100 dBm would be -100 dB ±1.5 dB plus 0.2 dB for every 10 dB step decrease below -37 dBm. There are 6 such steps from -100 to -37 dBm. Therefore the output range would be -100 dBm ±1.5 +(0.2 time 6) dB or -100 dBm ±1.5 +(1.2) dB or -100 dBm ±2.7 dB or -102.7 dBm to -97.3 dBm.

12. Disconnect the test equipment.

13. Set the 2520 output frequency to 2200 MHz.

14. Connect the power sensor unit of the power meter to the 2520 RF output. Set the 2520 output at the -20 dBm level.

15. Use the cursor keys to set the output power resolution digit at the 10 dB incremental position and turn the spin knob counterclockwise or use the increment key to decrease output level in 10 dB steps from -20 dBm to -60 dBm.

16. Observe the output level and verify it is within the acceptable range associated with each setting:

Output (dBm)	Range (dBm)
-20	-21.50 to -18.50
-30	-31.50 to -28.50
-40	-41.70 to -38.30
-50	-51.90 to -48.10
-60	-62.10 to -57.90

17. Disconnect the test equipment.

4.14 OUTPUT POWER LEVEL FLATNESS TEST

SPECIFICATION: ±1.2 dB

METHOD: A power meter is used to measure the most representative output levels across the 2520 frequency spectrum.

EQUIPMENT: (9b)

PROCEDURE:

1. Connect the power sensor unit of the power meter to the 2520 RF output. Set the 2520 output at the +13 dBm level.

2. Use the spin knob/cursor keys (see Section 3.5.2.2, if necessary) to sweep through the 2520 frequency spectrum (.2 MHz to 2200 MHz) while monitoring output power on the power meter. Verify the highest output power is within 2.4 dB of the lowest output power across the frequency range. (Use the resolution digit set at .1 MHz from .2 to 1 MHz; set the resolution digit at 1 MHz from 1 MHz to 2200 MHz).

3. Set the 2520 output level at +3 dBm. Repeat step 2.

4. Set the 2520 output level at -7 dBm. Repeat step 2.

5. Disconnect the test equipment.

4.15 OUTPUT IMPEDANCE TEST

SPECIFICATION: 50 Ω, with VSWR <1.6:1 at output power <-7 dBm

METHOD: A VSWR bridge, spectrum analyzer, and sweep generator are used to measure output impedance across the frequency range.

EQUIPMENT: (5) (12) (13)

PROCEDURE

1. Connect the RF input of the VSWR bridge to the sweep generator output. Connect the VSWR reference short across the bridge test port. Connect the bridge RF output port to the spectrum analyzer input.

2. Set the sweep generator to sweep from 0.2 - 2200 MHz using a 20 second sweep at a power level of +10 dBm. Store this data in the spectrum analyzer as the reference level.

3. Set the 2520 for an output frequency of 50 MHz at a -7.1 dBm output power level.

4. Remove the reference short from the test port on the VSWR bridge and connect the 2520 output to the test port.

5. Use the sweep generator to manually sweep the frequency range (.2 MHz to 2200 MHz) again. Compare these spectrum analyzer readings to the spectrum analyzer reference level from step 2. Record the worst case frequency and level. The worst case level should be <-12.8 dB from the reference level.

4.16 EXTERNAL REFERENCE TEST

SPECIFICATION

External source specification

METHOD

A signal generator is used to verify the 2520 external reference circuitry.

EQUIPMENT

(1)

PROCEDURE

1. Determine the error in the external source.

2. Connect the external source to the external reference input on the rear panel of the 2520. Set the source at 1 volt peak-to-peak (+10 dBm) and 1 MHz. Set the 2520 rear panel external reference select switch to the "1 MHz" position.

3. Set the output frequency for the 2520 at 100 MHz and set the power level to 0 dBm.

4. Verify that the 2520 output frequency is within the external source limits.

5. Set the 2520 rear panel external reference select switch to the "5 MHz" position. Set the external source at 5 MHz.

6. Repeat step 4, above.

7. Set the 2520 rear panel external reference select switch to the "10 MHz" position. Set the external source to 10 MHz.

8. Repeat step 4, above.

9. Disconnect the external source and set the rear panel reference select switch to the appropriate position (read Section 3.4, item 3). If the internal reference source is used, this switch must be in the NT position. (If this switch is not in the INT position when the internal reference is used, the power up self test will give an error 18 message and the unit will not operate. Read Sections 5.5 through 5.5.2 for greater detail.)

4.17 SAMPLE PERFORMANCE TEST RECORD

PERFORMANCE TEST RECORD, MODEL 2520 S/N _____

DATE OF TEST _____

(Performance tests are listed below by section number, test name, and test specification. Test equipment used and test results are to be entered in their appropriate sections, as indicated below.)

4.2 FREQUENCY RESOLUTION AND RANGE TEST

SPECIFICATION	MIN FREQ	MAX FREQ	RESOLUTION
	.2 MHz	2200 MHz	10 Hz < 1100 MHz 20 Hz > 1100 MHz

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results

SPIN KNOB RESOLUTION:

FREQUENCY RANGES (MHz)	2520 RESOLUTION Required	Actual
0.20000 - 0.20010	10 Hz	_____
0.20010 - 0.20100	100 Hz	_____
0.20100 - 0.21000	1 kHz	_____
0.21000 - 0.30000	10 kHz	_____
0.30000 - 1.00000	100 kHz	_____
1.00000 - 10.00000	1 MHz	_____
10.00000 - 100.00000	10 MHz	_____
100.00000 - 1000.00000	100 MHz	_____
1000.00000 - 2000.00000	1000 MHz	_____

FREQUENCY RANGE:

(Spin Knob) .2 MHz reading _____

2200 MHz reading _____

(Keypad) .2 MHz reading _____

2200 MHz reading _____

Frequency ranges and resolutions within specified limits _____

4.3 FREQUENCY ACCURACY TEST

SPECIFICATION All modes (CW, AM, and FM): ±2.5 ppm (±.00025%), 0 - 50° C

Reference Accuracy if option installed _____

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results

(1) Actual frequency at 500 MHz _____

(2) Frequency chosen in .2 - 137.5 MHz range _____

Actual frequency at (2) _____

(3) Frequency chosen in 137.5 - 275 MHz range _____

Actual frequency at (3) _____

(4) Frequency chosen in 275 - 550 MHz range _____

Actual frequency at (4) _____

(5) Frequency chosen in 550 - 1100 MHz range _____

Actual frequency at (5) _____

(6) Frequency chosen in 1100 - 2200 MHz range _____

Actual frequency at (6) _____

All frequencies within specified accuracies _____

4.4 HARMONICS TEST

SPECIFICATION < -25 dBc from 0.2 MHz to 0.4 MHz
< -30 dBc from 0.4 MHz to 1100 MHz
< -25 dBc > 1100 MHz

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results

OUTPUT LEVEL (dBm)	FREQ RANGE (MHz)	WORST CASE HARMONICS SECOND (dBc)	THIRD (dBc)
+13	.2 - .4	_____	_____
+13	.4 - 10	_____	_____
+13	10 - 1100	_____	_____
+13	1100 - 2200	_____	_____
+3	.2 - .4	_____	_____
+3	.4 - 10	_____	_____
+3	10 - 1100	_____	_____
+3	1100 - 2200	_____	_____
-7	.2 - .4	_____	_____
-7	.4 - 10	_____	_____
-7	10 - 1100	_____	_____
-7	1100 - 2200	_____	_____

Worst case harmonics are within specified limits _____

4.5 NON-HARMONICS TEST

SPECIFICATION

offset >5 kHz from carrier frequency:
<-50 dBc for carrier frequencies <137.5 MHz
<-60 dBc for carrier frequencies from 137.5 MHz to 1100 MHz
< -54 dBc for carrier frequencies > 1100 MHz
offset 500 Hz to 5 kHz from carrier frequency:
<-50 dBc, typically, for all frequency ranges

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results

Worst Case, 50 - 137.5 MHz range:

frequency (MHz) _____

level (dBc) _____

Worst Case Sidebands:

2520 OUTPUT FREQUENCY	SIDEBAND FREQUENCY (MHZ)	SIDEBAND LEVEL (dBc)
551.26 MHz	_____	_____
653.26 MHz	_____	_____
655.26 MHz	_____	_____
777.26 MHz	_____	_____
781.26 MHz	_____	_____
925.26 MHz	_____	_____
926.26 MHz	_____	_____
1099.26 MHz	_____	_____
1102.52 MHz	_____	_____
1306.52 MHz	_____	_____
1310.52 MHz	_____	_____
1554.52 MHz	_____	_____
1562.52 MHz	_____	_____
1850.52 MHz	_____	_____
1852.52 MHz	_____	_____
2198.52 MHz	_____	_____

Worst case non-harmonics are within specified limits _____

4.6 SUB-HARMONICS TEST

SPECIFICATION -25 dBc for frequencies > 550 MHz

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results

Sub-harmonic levels at 551 MHz carrier (f_o) and +13 dBm output:

1/2 (f_o) = (275.5 MHz) _____ dBc

3/2 (f_o) = (826.5 MHz) _____ dBc

Worst Case, 551 to 2200 MHz range:

(f_o) of worst 1/2 (f_o) _____ MHz

worst 1/2 (f_o) _____ MHz

worst 1/2 (f_o) level _____ dBc

(f_o) of worst 3/2 (f_o) _____ MHz

worst 3/2 (f_o) _____ MHz

worst 3/2 (f_o) level _____ dBc

Sub-harmonic levels at 551 MHz carrier (f_o) and -7 dBm output:

1/2 (f_o) _____ dBc

3/2 (f_o) _____ dBc

Worst case, 551 MHz to 2200 MHz at -7 dBm:

(f_o) of worst 1/2 (f_o) _____ MHz

worst 1/2 (f_o) _____ MHz

worst 1/2 (f_o) level _____ dBc

(f_o) of worst 3/2 (f_o) _____ MHz

worst 3/2 (f_o) _____ MHz

worst 3/2 (f_o) level _____ dBc

Worst case sub-harmonics are within specified limits _____

4.7 PHASE NOISE TEST

SPECIFICATION < -107 dBc/Hz at 500 MHz; 10 kHz offset from carrier frequency

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results

2520 OUTPUT FREQUENCY	PHASE NOISE (dBc/Hz)
500 MHz	_____

4.8 SWITCHING SPEED TEST

SPECIFICATION 200 mSec, maximum (Typically 100 mSec)

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results

FREQUENCY CHANGE (MHz)	TRACE SETTLING TIME (mSec)
550 to 550.1	_____
550.1 to 550	_____
389 to 389.1	_____
389.1 to 389	_____

Switching time is within specified limits _____

4.9 AM PERFORMANCE TESTS

SPECIFICATION

AM Accuracy (0 - 90%)	±(2% + 6% of setting); 0.2 to <1 MHz ±(2% + 4% of setting); 1 to <1100 MHz ±(2% + 6% of setting); 1100 to <2200 MHz
Distortion	at 90% AM = < 5% at 70% AM = < 3% at 30% AM = < 1.5%
AM Bandwidth	DC to 15 kHz; 0 to 50% AM

TEST EQUIPMENT USED	CALIBRATION DUE DATE
_____	_____
_____	_____
_____	_____
_____	_____

Test Results

Accuracy and Distortion at indicated output settings:

OUTPUT LEVEL (dBm)	AM DEPTH (%)	OUTPUT FREQUENCY (MHz)	AVERAGE ACCURACY (%)	DISTORTION (%)
+3	90	11		
+3	90	137		
+3	90	138		
+3	90	194		
+3	90	195		
+3	90	274		
+3	90	275		
+3	90	400		
+3	90	550		
+3	90	551		
+3	90	620		
+3	90	692		
+3	90	693		
+3	90	780		
+3	90	872		
+3	90	873		
+3	90	1000		
+3	90	1090		
+3	90	1100		
+3	90	1240		
+3	90	1384		
+3	90	1386		
+3	90	1560		
+3	90	1744		
+3	90	1746		
+3	90	2000		
+3	90	2200		
+3	70	11		
+3	70	137		
+3	70	138		
+3	70	194		
+3	70	195		
+3	70	274		
+3	70	275		
+3	70	400		
+3	70	550		
+3	70	551		
+3	70	620		
+3	70	692		
+3	70	693		
+3	70	780		
+3	70	872		
+3	70	873		
+3	70	1000		
+3	70	1090		

+3	70	1100	_____	_____
+3	70	1240	_____	_____
+3	70	1384	_____	_____
+3	70	1386	_____	_____
+3	70	1560	_____	_____
+3	70	1744	_____	_____
+3	70	1746	_____	_____
+3	70	2000	_____	_____
+3	70	2200	_____	_____
+3	30	11	_____	_____
+3	30	137	_____	_____
+3	30	138	_____	_____
+3	30	194	_____	_____
+3	30	195	_____	_____
+3	30	274	_____	_____
+3	30	275	_____	_____
+3	30	400	_____	_____
+3	30	550	_____	_____
+3	30	551	_____	_____
+3	30	620	_____	_____
+3	30	692	_____	_____
+3	30	693	_____	_____
+3	30	780	_____	_____
+3	30	872	_____	_____
+3	30	873	_____	_____
+3	30	1000	_____	_____
+3	30	1090	_____	_____
+3	30	1100	_____	_____
+3	30	1240	_____	_____
+3	30	1384	_____	_____
+3	30	1386	_____	_____
+3	30	1560	_____	_____
+3	30	1744	_____	_____
+3	30	1746	_____	_____
+3	30	2000	_____	_____
+3	30	2200	_____	_____
−7	90	11	_____	_____
−7	90	137	_____	_____
−7	90	138	_____	_____
−7	90	194	_____	_____
−7	90	195	_____	_____
−7	90	274	_____	_____
−7	90	275	_____	_____
−7	90	400	_____	_____
−7	90	550	_____	_____
−7	90	551	_____	_____
−7	90	620	_____	_____
−7	90	692	_____	_____
−7	90	693	_____	_____
−7	90	780	_____	_____
−7	90	872	_____	_____
−7	90	873	_____	_____

-7	90	1000		
-7	90	1090		
-7	90	1100		
-7	90	1240		
-7	90	1384		
-7	90	1386		
-7	90	1560		
-7	90	1744		
-7	90	1746		
-7	90	2000		
-7	90	2200		
-7	70	11		
-7	70	137		
-7	70	138		
-7	70	194		
-7	70	195		
-7	70	274		
-7	70	275		
-7	70	400		
-7	70	550		
-7	70	551		
-7	70	620		
-7	70	692		
-7	70	693		
-7	70	780		
-7	70	872		
-7	70	873		
-7	70	1000		
-7	70	1090		
-7	70	1100		
-7	70	1240		
-7	70	1384		
-7	70	1386		
-7	70	1560		
-7	70	1744		
-7	70	1746		
-7	70	2000		
-7	70	2200		
-7	30	11		
-7	30	137		
-7	30	138		
-7	30	194		
-7	30	195		
-7	30	274		
-7	30	275		
-7	30	400		
-7	30	550		
-7	30	551		
-7	30	620		
-7	30	692		
-7	30	693		
-7	30	780		

-7	30	872	_____	_____
-7	30	873	_____	_____
-7	30	1000	_____	_____
-7	30	1090	_____	_____
-7	30	1100	_____	_____
-7	30	1240	_____	_____
-7	30	1384	_____	_____
-7	30	1386	_____	_____
-7	30	1560	_____	_____
-7	30	1744	_____	_____
-7	30	1746	_____	_____
-7	30	2000	_____	_____
-7	30	2200	_____	_____

AM Bandwidth:

OUTPUT FREQUENCY (MHz)	RELATIVE CHANGE ON MODULATION METER (dB)
11	_____
137	_____
138	_____
194	_____
195	_____
274	_____
275	_____
400	_____
550	_____
551	_____
620	_____
692	_____
693	_____
780	_____
872	_____
873	_____
1000	_____
1090	_____
1100	_____
1240	_____
1384	_____
1386	_____
1560	_____
1744	_____
1746	_____
2000	_____
2200	_____

Accuracies, Distortion, and AM Bandwidth are within specified limits_____

4.10 RESIDUAL AM TEST

SPECIFICATION < -65 dBc; CW mode with 50 Hz to 15 kHz post detection bandwidth (PDBW)

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results

2520 OUTPUT FREQUENCY (MHz)	RESIDUAL AM
.2	_____
1	_____
1090	_____
1100	_____
2200	_____

Residual AM is within specified limits _____

4.11 RESIDUAL FM TEST

SPECIFICATION

Post detection bandwidth .05 - 15 kHz
< 30 Hz rms (.2 - 137.5 MHz)
< 10 Hz rms (137.5 - 275 MHz)
< 20 Hz rms (275 - 550 MHz)
< 40 Hz rms (550 - 1100 MHz)
< 80 Hz rms (> 1100 MHz)
Post detection bandwidth .3 - 3 kHz
< 15 Hz rms (.2 - 137.5 MHz)
< 7 Hz rms (137.5 - 275 MHz)
< 10 Hz rms (275 - 550 MHz)
< 20 Hz rms (550 - 1100 MHz)
< 40 Hz rms (> 1100 MHz)

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results (.05 - 15 kHz PDBW)

2520 OUTPUT FREQUENCY (MHz)	RESIDUAL FM
100.001	_____
125.001	_____
275	_____
325	_____
330	_____
389	_____
390	_____
463	_____
464	_____
550	_____

User Chosen Values:

_____	_____
_____	_____
_____	_____

Residual FM is within specified limits _____

4.12 FM PERFORMANCE TESTS

SPECIFICATION

FM Accuracy	±6% of setting, at internal rates (excluding residual FM)
Distortion	< 2% at internal rates for deviation < 100 kHz
FM Bandwidth	20 Hz to 100 kHz (0 Hz to 100 kHz with FSK option)
Deviation Range	For 1 kHz rate: 1 MHz peak for 3 - 137.5 MHz and 275 - 1100 MHz 500 kHz peak for 137.5 - 275 MHz 1.999 MHz peak for > 1100 MHz

TEST EQUIPMENT USED	CALIBRATION DUE DATE
_____	_____
_____	_____
_____	_____
_____	_____

Test Results

FM Accuracy and Distortion:

2520 FM DEVIATION (kHz)	INTERNAL SOURCE (Hz)	2520 OUTPUT FREQUENCY (MHz)	FM ACCURACY (kHz)	FM DISTORTION (%)
99.9	1000	275	_____	
99.9	1000	____ worst case (275-550 MHz)	_____	
99.9	1000	500	_____	_____
100	1000	500	_____	_____
99.9	400	500	_____	_____

FM Bandwidth:

Relative dB output change _____ dB

Deviation Range:

2520 Output Frequency (MHz)	Deviation Range (MHz)
389	_____
_____ user selected value (137.5 - 275 MHz range)	_____
_____ user selected value (1100 - 2200 MHz range)	_____

FM Accuracy, distortion, bandwidth, and deviation ranges are within specified limits _____

4.13 OUTPUT POWER ACCURACY TEST

SPECIFICATION ±1.3 dB for levels > -37 dBm
±1.5 + (0.1/10 dB step decrease) dB for power levels < -37 dBm and frequencies < 1100 MHz;
±1.5 + (0.2/10 dB step decrease) dB for power levels < -37 dBm and frequencies > 1100 MHz;

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results (Output Frequency < 1300 MHz)

2520 OUTPUT POWER (dBm)	ASSOCIATED POWER METER READINGS (dBm) 5 MHz	400 MHz	1090 MHz	_____ user chosen
+13	_____	_____	_____	_____
0	_____	_____	_____	_____
-10	_____	_____	_____	_____
-20	_____	_____	_____	_____
-30	_____	_____	_____	_____
-40	_____	_____	_____	_____
-50	_____	_____	_____	_____
-60	_____	_____	_____	_____
-70	_____	_____	_____	_____
-80	_____	_____	_____	_____
-90	_____	_____	_____	_____
-100	_____	_____	_____	_____
-110	_____	_____	_____	_____
-120	_____	_____	_____	_____
-130	_____	_____	_____	_____

Output power levels are within specified limits _____

Test Results (Output Frequency = 2200 MHz)

2520 OUTPUT POWER (dBm)	ASSOCIATED POWER METER READINGS (dBm) 2200 MHz
-20	_____
-30	_____
-40	_____
-50	_____
-60	_____

Output power levels are within specified limits _____

4.14 OUTPUT POWER LEVEL FLATNESS TEST

SPECIFICATION ±1.2 dB

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results

2520 OUTPUT LEVEL (dBm)	dBm VALUES ACROSS RANGE Minimum	Maximum
+13	_____	_____
+3	_____	_____
-7	_____	_____

Output power level flatness is within specified limits _____

4.15 OUTPUT IMPEDANCE TEST

SPECIFICATION 50 Ω, with VSWR < 1.6:1 at output power < -7 dBm

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results

Worst Case: frequency _____ MHz

power level _____ dBm

Output impedance across the frequency range is within specified limits

_____

4.16 EXTERNAL REFERENCE TEST

SPECIFICATION External source specification

TEST EQUIPMENT USED _____

CALIBRATION DUE DATE _____

Test Results

Error in external source _____ MHz

External input (MHz)	2520 Output (MHz)
1	_____
5	_____
10	_____

Frequency output is within external source limits _____

SECTION 5

MAINTENANCE

5.1 INTRODUCTION

This section provides maintenance information for the Wavetek Model 2520 RF Signal Generator. Maintenance consists of service information (fan/air filter maintenance and bottom cover removal instructions), the AutoCal® calibration procedures, user diagnostics, and a field calibration procedure. This section also contains a description of the instrument test sequence automatically performed when the power is turned on.

WARNING

High voltages are present in this unit. Do not operate this unit with any cover removed and the power on.

5.2 SERVICE INFORMATION

5.2.1 FAN/AIR FILTER MAINTENANCE

The rear-panel fan reduces operating temperature, and contributes to the long life of the instrument. The air filter installed in the bottom cover intake vents must be kept clean. Remove the bottom cover and clean the air filter as described below.

5.2.2 BOTTOM COVER REMOVAL

Remove power from the instrument. The bottom cover is secured by two screws at the rear of the unit. Remove the two screws. Slide the cover back and remove it. (Reverse this procedure to reinstall the cover.)

5.2.3 AIR FILTER CLEANING

The air filter is glued to the bottom cover. Use an air hose to direct a stream of air against the filter to clean it.

Reinstall the bottom cover.

5.3 AUTOCAL® CALIBRATION

The Wavetek Model 2520 RF Signal Generator uses an almost completely automatic calibration procedure (AutoCal®) to calibrate the circuits that determine output frequency and output power level. The AutoCal® procedure is one (1) of 22 procedures activated by the Operator/AutoCal® Keylock Switch on the rear panel of the 2520. Nineteen of the remaining 21 procedures are user diagnostics. The twenty-first allows the operator to set the GPIB address and end of string (EOS) terminator from the front panel. The user diagnostics and GPIB address/EOS terminator setting procedures are described in Section 5.4 of this manual. The twenty-second allows the operator to display the options installed in the 2520.

The detailed procedure to perform the Model 2520 calibration using AutoCal® is described below:

5.3.1 Turn on the Model 2520 and permit a warm up time of one hour (if necessary).

5.3.2 Turn off the Model 2520 for a few seconds.

5.3.3 Insert the OPERATE/AutoCal® key in the keylock on the rear panel and turn the key to the "AutoCal®" position. Turn on power.

5.3.4 The FREQUENCY display will show "2520 diag"; the LEVEL display will very briefly show "80" (if the GPIB option is installed) and "81" and then the MODULATION and LEVEL displays will be blank.

5.3.5 In one second the FREQUENCY display will show "SEL 01-22".

5.3.6 Use the numeric keyboard to enter "19", the number for the Auto-Cal® procedure. The number will be shown on the LEVEL display as it is entered. Then press the "+/-" key to initiate the procedure.

5.3.7 The "CAL" annunciator will be displayed in the bottom right section of the FREQUENCY display. (MOD and LEVEL displays are blanked during the calibration procedure.) The FREQUENCY display will indicate DELAY 5 and perform a countdown to 0. (DELAY 5 → DELAY 4 → DELAY 3 → etc; 5 second countdown).

5.3.8 The FREQUENCY display will display the message "SELECT" and then the message "Fr or L" to indicate the operator should select either the output frequency (Fr) calibration routine described in steps 5.3.9 to 5.3.9.7, below or the output power level (L) calibration routine described in steps 5.3.10 to 5.3.10.14. The Frequency calibration must be performed before the Output Power Level calibration.

5.3.9 Press the FREQ key to select the FREQUENCY calibration routine. The frequency calibration routine is completely automatic, requiring no operator input at any step. There are four frequency ranges (bands) across which the instrument is calibrated. The FREQUENCY display will identify the four bands as "OSC 1", "OSC 2", "OSC 3", and "OSC 4" during the calibration and also will indicate the point in the band being calibrated.

5.3.9.1 The first band/point calibrated will be shown as "OSC 1 00". The display will then indicate "OSC 1 01" as the next point (the next higher frequency) is calibrated. The final point in band one will be identified as "OSC 1 34". There are 35 points (frequencies) calibrated in band 1.

5.3.9.2 As Band 2 is calibrated, points will be identified as "OSC 2 00" through "OSC 2 39" for a total of 40 frequencies calibrated.

5.3.9.3 As band 3 is calibrated, points "OSC 3 00" to "OSC 3 45" will be displayed.

5.3.9.4 As band 4 is calibrated, points "OSC 4 00" to "OSC 4 51" will be displayed.

5.3.9.5 When the four bands have been calibrated, the FREQUENCY display will momentarily show "PASS" and then return the "SEL 01-22" message.

5.3.9.6 If an error occurs during the frequency calibration routine an error message ("Er 0" or "Er 1") will be displayed in the MODULATION display. The FREQUENCY display will stop (be frozen) at the oscillator number and the number of the point in the band being calibrated when failure occurred. The appearance of an "Er 0" or "Er 1" message indicates a hardware problem that should be corrected. (Wavetek offers an optional Service Manual that includes information useful to trouble-shoot/repair the Model 2520. Wavetek recommends returning the unit to the factory for repair, after factory authorization, unless the customer has highly qualified maintenance personnel that are experienced at RF repair work.)

5.3.9.7 After the "Er 0" or "Er 1" message and its associated oscillator number/band point number is recorded, the spin knob may be turned to restore the "SEL 01-22" function and request a diagnostic, as appropriate (Section 5.4 describes the diagnostics incorporated into this unit).

5.3.10 When the "Fr or L" message is on the FREQUENCY display (review steps 5.3.3 to 5.3.8 if necessary), press the LVL (Level) key to select the output power level calibration routine. The frequency calibration described above must be performed before the output power level calibration to ensure the frequency points used in the level calibration are accurate.

5.3.10.1 Connect an RF power meter with range from .2 MHz to 2200 MHz to the Model 2520 RF output connector before proceeding with this calibration.

5.3.10.2 The output power level calibration requires the operator to use the keyboard and the spin knob or increment (↑ ↓) keys to make entries at various stages in the procedure.

5.3.10.3 The initial level calibration procedure messages on the three front panel displays are:

MODULATION display: "Adj"
FREQUENCY display: "0 0.2 MHz"
LEVEL display: "x.x dBm", with "x.x" being a number between +6.0 and -6.0, inclusive.

Each display message is described in greater detail below.

5.3.10.4 The MODULATION display will maintain the message "Adj" throughout this procedure. This message informs the operator that the Model 2520 output power level may be adjusted using the spin knob.

5.3.10.5 This output level calibration is performed at 17 different output frequencies. The frequencies are given index numbers from 0 to 16 (corresponding to frequency points from 0.2 MHz to 2200 MHz). The frequency display will show the calibration information with respect to the index point being calibrated (0 - 16 in Table 5-1) and the actual frequency output at the calibration point (also shown in Table 5-1).

Table 5-1. Level Calibration Points

INDEX POINT	FREQUENCY (MHz)
0	0.2
1	2
2	10
3	20
4	100
5	300
6	500
7	700
8	900
9	1050
10	1100
11	1300
12	1500
13	1700
14	1900
15	2100
16	2200

5.3.10.6 At each calibration index point the output power level must be read on the RF meter and must be set to 0 dBm (±0.1 dB) by the operator. Output power is adjustable over the range from -6.0 to +6.0 dB. Turn the spin knob in a clockwise direction to increase the output power. Turn the spin knob counterclockwise to decrease the output. (The up/down increment keys also may be used to change the output level.)

5.3.10.7 As the output power level is adjusted (if necessary) at each frequency calibration point, the Model 2520 will automatically determine the amount of flatness correction that was necessary at that frequency point to make the output power level equal 0 dBm. This correction factor in units of dB will be shown on the LEVEL dis-

play. It will change at any given calibration point as the output power is adjusted to 0 dBm with the spin knob or increment keys. (The actual correction factor is determined as dB units.)

5.3.10.8 The output power level calibration routine begins at calibration index number 0 and output frequency 0.2 MHz. The left and right "arrow" cursor keys below the spin knob are used to advance from one calibration point to the next or recall an earlier calibration point. The right cursor key will call up the next higher index. The left cursor key will recall the next lower index. Exceptions to this process occur at both end points. Pressing the left arrow cursor key when the calibration point is at index 0 (.2 MHz) will not change the index. Pressing the right arrow cursor key at index 16 (2200 MHz) will end the level calibration routine and generate the "SEL 01-22" message from which additional diagnostics are selected (see Section 5.4).

5.3.10.9 To perform the output power level calibration, first select the routine (steps 5.3.1 through 5.3.8 and then 5.3.10).

5.3.10.10 At each calibration index number (0 - 16) use the spin knob or increment keys to adjust the 2520 output power level to 0 dBm ±.1 dB as indicated on the RF power meter. Note the amount of flatness correction at each index (LEVEL display reading) after the output is set to 0 dBm ±0.1 dB.

5.3.10.11 Record the maximum correction required and retain that value as a reference for later calibrations. (Changes in maximum correction required from one calibration to the next may indicate potential trouble areas. For example, an increase in several dB from one calibration to another may indicate a bad connector, a dirty instrument, etc.)

5.3.10.12 When the calibration is completed each of the 17 index points (0 - 16) will be adjusted for a 0 dBm output at each of the 17 frequencies. The flatness correction required at each frequency will be stored in memory (RAM) to use to interpolate comparable corrections for the frequencies between the calibration points.

5.3.10.13 If power is lost during performance of an output power level calibration before the final adjustment (at index 16) is completed, when power is reapplied the 2520 will use a flatness table stored in permanent memory (ROM). The permanent table is used to avoid possible inclusion of bad index points (not adjusted to a 0 dBm output) in the RAM table developed during an incomplete calibration routine. Note that if power loss occurs, when the 2520 is powered up again its RF level accuracy will still be within specifications for the unit but will not be as accurate as those for a correctly calibrated 2520.

5.3.10.14 When the final point (index number 16) has been adjusted to a 0 dBm output level, press the right arrow cursor key to exit the AutoCal® routine and recall the "SEL 01-22" message. (The display will momentarily show "PASS" before the "SEL 01-22" message appears.)

5.3.11 To exit the Diagnostics/AutoCal® routines turn off power. Turn the keyswitch on the 2520 rear panel to the "OPERATE" position and remove the key. Turn on power again and resume normal operation.

5.3.12 If the Level calibration procedure is not completed before the Operate/AutoCal® keylock switch is returned to the "Operate" position, the values obtained during the portion of the procedure completed will not be stored in memory. Therefore, always complete the calibration (to the display "SEL 01-22") before exiting the calibration routine.

5.4 USER DIAGNOSTICS

The user diagnostics allow the user to verify proper operation of 2520 subsystems and to perform an almost completely automatic calibration (AutoCal®) of the unit. When the 2520 is in user diagnostics, any command across the GPIB bus will be ignored.

5.4.1 To activate the user diagnostics the operator must turn off the Model 2520 for a few seconds. Insert the OPERATE/AutoCal® key into the rear panel keylock switch and turn the switch to the "AutoCal®" position.

5.4.1.1 Turn on the 2520.

5.4.1.2 The FREQUENCY display will show "2520 diag" to indicate activation of the diagnostics. (The MODULATION and LEVEL displays will be blank.)

5.4.1.3 If the GPIB option is installed, the 2520 will immediately perform the GPIB Data Exchange Test described in detail in Section 6.4 of this manual. The LEVEL display will very briefly show an "80" while the test is performed.

5.4.1.4 Diagnostics require a functional keyboard. The 2520 will immediately perform a test to verify there are no keyboard keys that are sticking. During the test, the LEVEL display will very briefly show an "81". If a key is sticking, an "Err" message will begin blinking on/off in the MODULATION display. The key code number associated with the sticking key will be shown in the LEVEL display. (Keycodes are shown in the discussion of the Keyboard Test, Section 5.4.10 of this chapter.)

5.4.2 After the key test is completed successfully (about one second after power up) the FREQUENCY display will show "SEL 01-22", a request to use the numeric keyboard to enter the number associated with the diagnostic (test) to be performed. The available choices are shown in Table 5-2. Each of the diagnostics listed are described briefly in the following sections, beginning at Section 5.4.10. (Entry #21, the GPIB Address/EOS Terminator listing, is not a diagnostic. It is included in this list because it is under keylock control. For security reasons the GPIB address and EOS terminator cannot be changed from the front panel when the unit is in its normal operating condition.)

Table 5-2. Diagnostic Tests Available

Entry #	Diagnostic
01.	Internal RAM Test
02.	Parallel Port Test
03.	Internal Timer Test
04.	Bankswitching Test
05.	External RAM Test
06.	ROM #1 Test
07.	ROM #2 Test
08.	ROM #3 Test
09.	GPIB Board Test
10.	Keyboard Test
11.	Display Test
12.	Spin knob Test
13.	Coarse Tuning Control DAC Test
14.	Internal Mod Control DAC Test
15.	External Mod Control DAC Test
16.	Carrier Level Control DAC Test
17.	Deviation Correction DAC Test
18.	Analog Status Feedback Test
19.	AutoCal® Calibration
20.	Default Settings
21.	GPIB Address/EOS Terminator
22.	Programmed Options

5.4.3 As the number associated with the diagnostic test is entered, it will be shown on the LEVEL display. A one or two digit number may be entered to request the tests. A single digit "1" or a two digit "01" entry will both request the Built In RAM test. Entry of a "00" and entry of a number greater than "22" will be ignored (no action taken after execution - see step 5.4.5, below).

5.4.4 If the wrong number is entered there are two procedures to remove it and enter the correct one.

5.4.4.1 The user may "overwrite" a previously entered digit(s) to enter the correct number. There are only two positions on the LEVEL display into which the digits entered will be written. Pressing a new digit will place that digit in the right-hand position and shift the previous right-hand digit into the left-hand position. The previous left-hand digit will be overwritten.

5.4.4.2 The period "." key may be pressed to clear the LEVEL display (remove the digits) and then enter the correct digits.

5.4.5 After the correct diagnostic entry number is entered, the test is initiated by pressing the "+/-" key.

5.4.6 During the time the majority of the diagnostics are being performed the FREQUENCY display will indicate "running..". Exceptions are discussed with their associated tests beginning in Section 5.4.10. After a test is successfully completed the FREQUENCY display will indicate "PASS" and then show the "SEL 01-22" message.

5.4.7 If an error is detected during a test, the MODULATION display typically will show the message "Err" blinking on/off. An associated error code number will be shown in the LEVEL display. The error code will not blink on/off.

5.4.7.1 The user may elect to discontinue further testing and begin troubleshooting or recalibration to determine and/or correct the problem causing the test failure.

5.4.7.2 The user may elect to perform additional diagnostics. To exit a failed test and select another test, turn the spin knob. This will recall the "SEL 01-22" message of step 5.4.2, above.

5.4.8 To exit the GPIB Address/EOS Termination procedure (entry #21), press the +/- key. The message "SEL 01-22" will be recalled.

5.4.9 When all desired tests have been performed, the 2520 is returned to normal operation by turning off power, turning the keylock switch on the rear panel to the "OPERATE" position, removing the key, and then turning on power again.

5.4.10 The diagnostics are described briefly in the following sections. Descriptions occur in the order the tests are listed in Table 5-2 and are identified by the entry number and title shown in Table 5-2. Diagnostics are verifications of proper operation. They also provide valuable troubleshooting information if a failure occurs. Please note that although the 2520 is simple to operate and calibrate, it is a very sophisticated electronic instrument. Troubleshooting and repairing a malfunctioning unit requires the Model 2520 Service Manual, sold separately, and personnel with technical expertise and experience with this type of instrument. Wavetek recommends return of a malfunctioning unit to the factory for repair (after factory authorization).

ENTRY NUMBER 01 - INTERNAL RAM TEST

The internal RAM test verifies proper operation of the RAM on the CPU (Central Processing Unit) and therefore verifies this part of the processor circuitry. Failure of this RAM test may be indicated by nonsense or no message on the front panel displays or the error message "Err" blinking on/off on the MODULATION display and the error code "01" on the LEVEL display.

ENTRY NUMBER 02 - PARALLEL PORT TEST

The parallel port test verifies proper operation of two parallel port registers associated with the CPU. Failure will be indicated by the blinking (on/off) message "Err" on the MODULATION display and error code "02" on the LEVEL display.

ENTRY NUMBER 03 - INTERNAL TIMER TEST

This test verifies the internal clock and the counting circuitry used in the CPU timer, verifying proper operation of the timer. Failure is indicated by the blinking (on/off) message "Err" on the MODULATION display and error code "03" on the LEVEL display.

ENTRY NUMBER 04 - BANKSWITCHING TEST

The CPU contains 16 banks of RAM and 10 banks of ROM. The bankswitching test verifies that information is written to the correct RAM/ROM bank. Failure is indicated by the error message "Err" blinking on/off on the MODULATION display and error code "04" on the LEVEL display.

ENTRY NUMBER 05 - EXTERNAL RAM TEST; ENTRY NUMBER 06 - ROM #1 TEST: CORE/ DIAGNOSTIC CORE CHECKSUM; ENTRY NUMBER 07 - ROM #2 TEST: DEFAULT/DIAGNOSTIC/ RF/CAL CHECKSUM; ENTRY NUMBER 08 - ROM #3 TEST: DISPLAY/UTILITIES/RF2/x4CHECK-SUM

The four RAM/ROM tests listed above verify proper operation of the RAM or ROM identified in the test title. The ROM containing the default/diagnostic settings for the instrument, for example, is tested when the ROM #2 Test is performed. Error messages generated if a test is failed result in the standard message "Err" blinking on/off in the front panel MODULATION display with the error code "xx" (the entry number for the test) shown on the LEVEL display.

ENTRY NUMBER 09 - GPIB BOARD TEST

This test is described in Section 6.5 of this manual.

ENTRY NUMBER 10 - KEYBOARD TEST

This test may be used to verify that each key on the keyboard functions properly. It also demonstrates that all the keycodes are correct. The keycodes, including option key codes, are shown in Table 5-3. During the keyboard test, the number "10" will be displayed in the LEVEL display to indicate this test is active and the word "codE" will be shown in the FREQUENCY display.

Verify each keycode by pushing down each key. The keycode associated with each key will be displayed on the FREQUENCY display.

For example, if the right cursor key (→) is pressed, the FREQUENCY display will show "codE 3E". Pressing the numeric "1" key will generate the message "codE 31". The word "codE" will be displayed throughout this text.

When a key is released, the two digit code on the FREQUENCY display will disappear (be blanked).

Exit this test by turning the spin knob or pressing either up/down (↑ ↓) increment key. The display will briefly show "PASS", then the "SEL 01-22" message will appear.

Table 5-3. Keycode List

Key Name	Key Code
-->	3E
RF on/off	57
%, dBm	5a
kHz, mV	59
MHz, µV	58
<--	3c
+/-	2d
0	30
1	31
2	32
3	33
4	34
5	35
6	36
7	37
8	38
9	39
.	2E
Level	4c
Freq	46

Local	4F
Recall	52
Store	53
Mod off	55
Ext FM	4b
Int FM	48
Mod Freq	44
Ext AM	4a
Int AM	47
Freq Step	6E
SRQ	71
ADDR	6a
TERM	69
FSK (Opt)	6b
Pulse Mod (Opt)	70
Level Step (Opt)	75
RAD (Opt)	77
Int Phase Mod (Opt)	79
Ext Phase Mod (Opt)	7a

ENTRY NUMBER 11 - DISPLAY TEST

The goal of this test is to verify that each segment of each display can be individually turned on and off. This test is performed by first turning on all the segments and then automatically turning them off one after another. During this test there is no feedback to the CPU as to what is displayed. The user must observe the displays very carefully as this test proceeds. The sequence of individual elements as they will be turned off is shown in Table 5-4. Note that several of the annunciators shown in Table 5-4 are for options and future use.

ENTRY NUMERIC 12 - SPIN KNOB TEST

This test verifies correct operation of the spin knob. At the beginning of the test, all three front panel displays are blanked. The left most cursor element on the leftmost display (MODULATION display) will be turned on. As the spin knob is turned clockwise, the cursor will move from left to right through all three displays. When the cursor reaches the rightmost digit of the rightmost display (LEVEL display) it will wrap around and start from the leftmost end again. The cursor will stop when spin knob rotation is stopped. Turning the spin knob counterclockwise will move the cursor in a left-to-right direction through the three displays. If spin knob failure occurs during the process, the cursor will stand still. Press the period (.) key to exit this test.

ENTRY NUMBER 13 - COARSE TUNING CONTROL DAC TEST; ENTRY NUMBER 14 - INTERNAL MODULATION CONTROL DAC TEST; ENTRY NUMBER 15 - EXTERNAL MODULATION CONTROL DAC TEST; ENTRY NUMBER 16 - CARRIER LEVEL CONTROL DAC TEST; ENTRY NUMBER 17 - DEVIATION CORRECTION DAC TEST

The control DAC tests listed above verify proper operation of the control DAC identified in the test title. All control DACs are tested using the spin knob to directly control the DAC output voltage. During a control DAC test the front panel FREQUENCY display will show the bit pattern in hexadecimal as it is sent out to the DAC. When the spin knob is turned in a clockwise direction the bit pattern shown will increase from 0 to FF for the Deviation Correction DAC and from 0 to 3FF for the other DACs listed above. The operator must observe the bit pattern and verify it goes through the range from 0 to FF or 0 to 3FF. The bit pattern will decrease when the spin knob is turned in a counterclockwise direction. During any control DAC test the MODULATION display will indicate "dAC" and the FREQUENCY display will show the number of the DAC being tested (1-5) and the bit pattern currently being written to the DAC. Control DACs are listed above in the 1-5 DAC number sequence from first to last. The Coarse Tuning Control DAC is DAC #1; the Deviation Correction DAC is DAC #5. For example a FREQUENCY display indication "1 035E" shows that control DAC number "1" is being tested and the current hexadecimal value being written is "35E".

To exit any control DAC test press the decimal period key (.).

Table 5-4. Display Test Turn Off Sequence

MODULATION DISPLAY	REMOTE	
	MOD RATE	
	FM OVERMOD	
	-	minus sign
	1.8.8.8.	numerical digits in order (segments a-g and associated periods
	µV	
	mV	
	dBm	
	kHz	
	%	
	LEVEL STEP	
	INT AM	
	INT FM	
	RF ON	
	RF OFF	
	400 Hz	
	1000 Hz	
	TRIPPED	
	EXT AM	
	EXT FM	
	UNLVD	
	DEV	below UNLVD
	FSK	
	EXT	below FSK
	DEV	beside FSK
	PM	
FREQUENCY DISPLAY	LOCATION	
	88	numerical part of Location Address
	GPIB ADDR	
	NO SETTING	
	STORED	
	RECALLED	
	|	division bar between memory location and remainder of display
	SRQ	
	FRQ	
	STEP	
	8.8.8.8.8.8.8.8.	numerical digits for frequency value in order (segments a-g) and associated periods
	GHz	
	MHz	
	kHz	
	OUTPUT FREQ	
	MOD FREQ	
	TERM	
	CR/	
	LF/	
	EOI	
	LAST CHAR/EOI	
	UNLOCKED	
	EXT REF	
LEVEL DISPLAY	Sequence is identical to that of MODULATION display.	

ENTRY NUMBER 18 - ANALOG STATUS FEEDBACK TEST

The analog status feedback test checks the following six status bits:

1. The main loop unlock indicator (LUL)
2. The upper frequency unleveled indicator (UFU)
3. The carrier unlevel indicator (CUL)
4. The 400 Hz feedback clock (400)
5. The FM overdeviation indicator (Fod)
6. The automatic phase control (APC)

While each test is running, the FREQUENCY display will show "run..." followed by the test code shown in parentheses above. The LEVEL display will continue to show the test number "18". Failure to successfully complete any of the six checks will generate the error message "Err" on the front panel MODULATION display. The message will blink on/off. After turning the spin knob, the "Err" message will be removed and the test will continue to check any remaining status bits.

ENTRY NUMBER 19 - AutoCal® CALIBRATION

This procedure is the almost completely automatic calibration procedure for the Model 2520. It is described in detail in Section 5.3 of this manual.

ENTRY NUMBER 20 - DEFAULT SETTINGS

This procedure will load the factory default settings into the current settings locations in the continuously powered RAM. Calibration values are not affected. The display will read "Default Loaded" during the procedure. This procedure is primarily for factory use but also may be used to verify RAM loading/storage.

The default conditions are shown in Table 5-5.

Table 5-5. Default Settings

MOD	OFF
FREQ	1 MHz
LEVEL	0 dB
INT AM	50%
EXT AM	50%
INT FM	10 kHz
EXT FM	10 kHz
RF	OFF
INT RATE	100 Hz
FREQ STEP	0 Hz

ENTRY NUMBER 21 - GPIB ADDRESS/EOI TERMINATOR

Entry of a "21" allows the operator to set/change the GPIB address for the unit and the end of string (EOS) terminator from the front panel. The current GPIB address and EOS terminator will be displayed on the FREQUENCY display.

The operator must press the ADDR key to initiate the address changes procedure. The two digit address may then be entered using the keyboard. A GPIB address of "2" must be entered as "02". Digits fill in from right to left, i.e. the first digit entered will appear in the "units" (ones) position. When the second digit is entered, it will enter the "units" position and the first digit entered will be moved to the "tens" position. Addresses from 00 to 30 are acceptable.

The EOS terminator is changed by pressing the TERM key until the correct EOS terminator is displayed. Pressing the TERM key will cause the unit to toggle between the possible choices:

LF
LF/EOI
CR/LF/EOI
LAST CHAR/EOI

To exit this procedure, press the +/- key. The "SEL 01-22" message will appear on the FREQUENCY display.

ENTRY NUMBER 22 - PROGRAMMED OPTIONS

Entry of a "22" allows the operator to display the options that have been programmed into the Model 2520. Before

the options are displayed, a checksum test is performed to verify options have been loaded properly. A checksum failure will generate the standard error message ("Err" blinking on/off on the MODULATION display and error code "22" on the LEVEL display). Options are programmed at the factory.

After the checksum test is completed successfully, programmed options will be displayed as follows. The MODULATION display will show the key code (see Table 5-3) associated with the first option displayed and the appropriate option annunciator. The FREQUENCY display and LEVEL display will show "OPtionS" and "22", respectively, continually during test 22. Pressing the right arrow cursor key (→) will call up the next option key code and associated annunciator to the MODULATION display, when more than one option has been programmed into the unit. When all options have been displayed by pressing the → key, the front panel will show the "SELECT 01-22" message. If no options have been programmed, "no" and "OPtionS" will be displayed in the MODULATION and FREQUENCY displays, respectively, and the "SELECT 01-22" message will be recalled after a short time.

Pressing the period "." key at any time will recall the "SELECT 01-22" message.

5.5 FIELD CALIBRATION, 2520

5.5.1 Field calibration for the Wavetek Model 2520 Signal Generator includes power supply adjustment, doubler output level (frequencies above 1100 MHz) adjustment, and adjustment of the internal reference source (TCXO). Field calibration should be performed only when the AutoCal® procedure will not bring the unit into its specified operating range(s). Unit diagnostics and the AutoCal® procedure are parts of the field calibration procedure and must be performed in the order specified in the following sections.

5.5.2 PERSONNEL SAFETY CONSIDERATIONS require the maintenance of standard safety precautions when working around 100-240 VAC. Be aware that when the top cover of the unit is removed there is 120 VAC at the back of the display board, just behind the front panel.

5.5.3 When the top cover is removed from this unit, access holes in the protective covers for the Amplifier, Oscillator, and Doubler Assemblies will be exposed (see Figure 5-1 for assemblies locations). DO NOT ADJUST THESE POTENTIOMETERS. They are strictly for factory use only.

5.5.4 Field Calibration Procedure:

1. To check/adjust the power supplies, turn off the unit. Remove the two screws in the back of the top cover and slide the cover off. The power supplies are at the back of the unit. Their adjustment potentiometers are on the power supply board at the bottom of the power supplies (see Figure 5-2).

a. Measure the +18 VDC supply at pin 1 of J1002. Adjust R1005 for a value of +18 VDC ± 0.3 V, if necessary.
b. Measure the +18 VDC supply at pin 2 of J1002. Adjust R1030 for a value of +18 VDC ± 0.3 V, if necessary.
c. Measure the -18 VDC supply at pin 3 or pin 4 of J1002. Adjust R1010 for a value of -18 VDC ± 0.3 V, if necessary.
d. Measure the +8 VDC supply at pin 5 or pin 6 or pin 7 of J1002. Adjust R1019 for a value of +8 VDC ± 0.3 V, if necessary.

2. Let the unit warm up for one half hour.

3. Turn off the unit. Place it in the AutoCal® mode by turning the Operate/AutoCal® keylock switch on the rear panel to the AutoCal® position. Turn on the unit.

4. Select test 19 (AutoCal®). Press the +/- key to activate the calibration.

5. Press the FREQ key to select the frequency calibration. When the frequency calibration is completed the display will show "SEL 0-21". Turn off the unit. Turn the Operate/AutoCal® keylock switch to the Operate position. Turn on the unit.

6. Remove the RF cable between the Amplifier Module and the Doubler Module (see Figure 5-1). Connect a power meter to the Amplifier Module Output (from which the cable was just removed.)

7. Turn the unit onto its left side. Remove the two screws at the rear of the bottom cover, then carefully slide off the bottom cover (see Figure 5-3). Remove the bottom shield. The Doubler Control Board (item 2 of Figure 5-3) will be exposed.

8. Set the 2520 output frequency to 1500 MHz.

9. Adjust the sole potentiometer on the Doubler Control Board for a power meter reading between +13 dBm and +13.2 dBm.

10. Use the front panel controls to vary the output frequency from 1100 MHz to 2200 MHz to verify output level does not fall below +12.5 dBm across this range. If it does, find the low point and use the Doubler Control Board adjustment to set the low point at +12.5 dBm.

11. Turn off the unit. Disconnect the power meter and reconnect the RF cable. Turn the Operate/AutoCal® keylock switch to the AutoCal® position. Turn on the unit.

12. Select test 19 (AutoCal®). Press the +/- key to activate the calibration.

13. Press the LVL key to select the level calibration. Connect a power meter to the RF Out Connector on the front panel. Perform the power level calibration described in the maintenance section (section 5) of this manual.

14. When the level calibration is completed the display will show "SEL 0-21". Run diagnostic tests 0-12 and 18 and 19.

15. When these tests are completed, turn off the unit. Turn the Operate/AutoCal® keylock switch to the Operate position. Turn on the unit.

16. Remove the right side panel, exposing the access hole centered along the right side of the unit about 4.7 inches from the front panel.

17. Set the output frequency to 500 MHz, with all modulation off.

18. Connect a frequency counter to the RF Out connector. Use an external 10 MHz reference with an output accuracy of at least ±0.05 ppm for the counter.

19. Adjust the internal source (TCXO) through the right side panel access hole (step 16) for a counter reading of 500 MHz ± 50 Hz.

20. Disconnect the frequency counter. Carefully replace all removed hardware. Resume normal operation.

5.6 POWER UP TESTS

Each time power is applied to the 2520 (the unit is turned on) it performs an automatic sequence of tests to verify various subsystems are functional.

5.6.1 The following sections describe the test sequence that occurs. The test entry number (for diagnostics) and test number (for the automatic tests ran only at power up) will be shown in the LEVEL display during the time the associated test is run.

1. All system interrupts are disabled (no indicator).

2. All segments on the front panel displays are turned on for one second.

3. The FREQUENCY display shows "SELF CHEC".

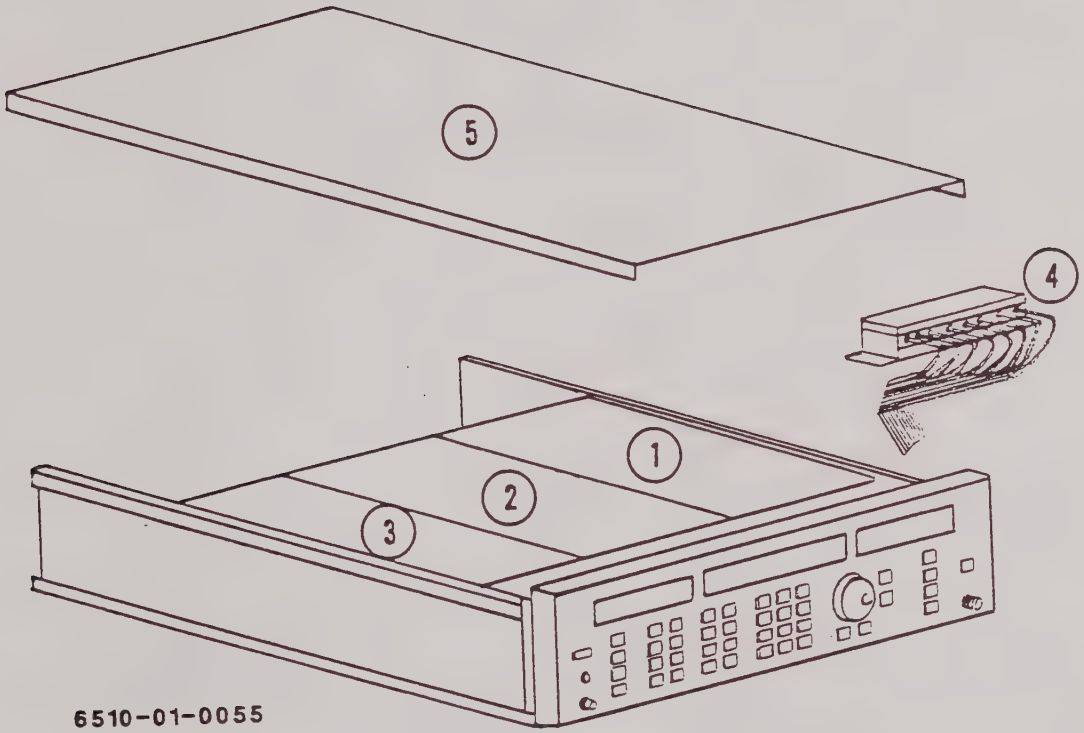

Figure 5-1. Top View, 2520

Key:
1. Amplifier Assembly
2. Oscillator Assembly
3. Doubler Assembly
4. Attenuator Assembly
5. Top Cover

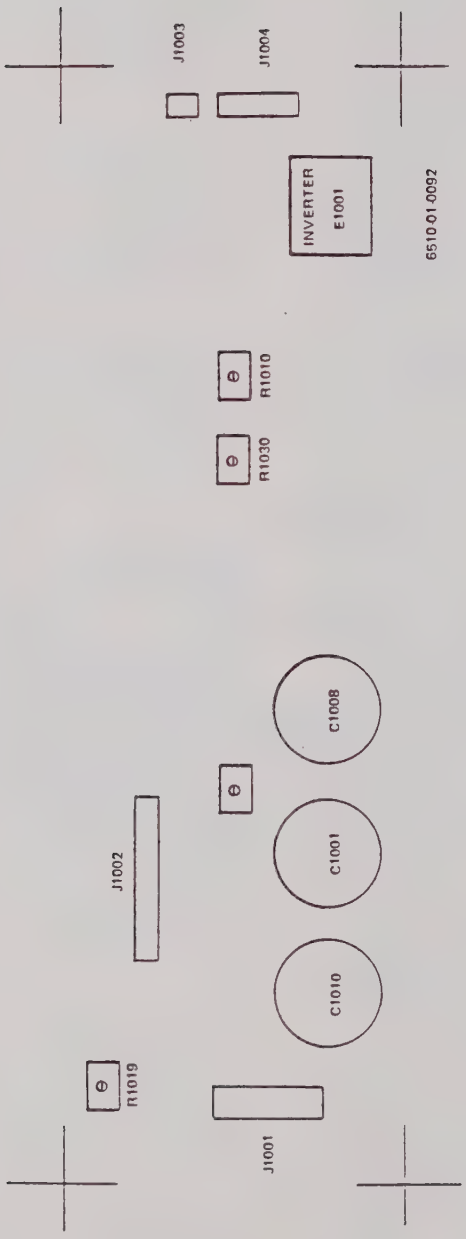

Figure 5-2. Power Supply Board Potentiometer Locations

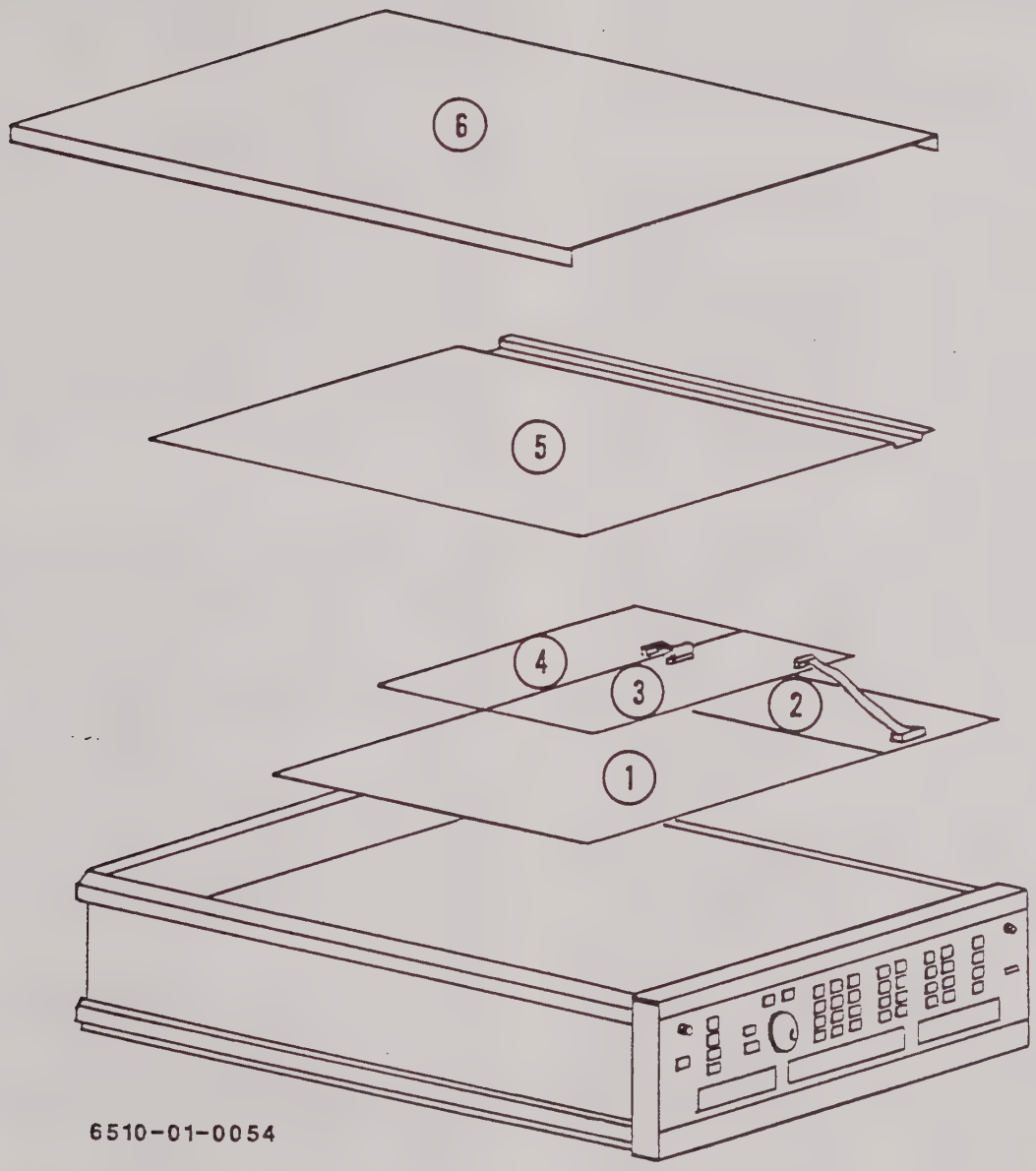

Figure 5-3. Bottom View, 2520

Key:
1. Main Board
2. Doubler Control Board
3. Microprocessor Board
4. GPIB Board
5. Bottom Shield
6. Bottom Cover

4. The Internal Ram Test is performed (see Section 5.4.10, entry number 01).

5. The Parallel Port Test is performed (see Section 5.4.10, entry number 02).

6. The Internal Timer Test is performed (see Section 5.4.10, entry number 03).

7. The Bankswitching Test is performed (see Section 5.4.10, entry number 04).

8. The External RAM Test is performed (see Section 5.4.10, entry number 05).

9. The Core ROM Checksum Test is performed (see Section 5.4.10, entry number 06).

10. The 400 Hz feedback clock is tested for proper operation. The LEVEL display will show the test number "18". If the EXTERNAL/INTERNAL reference switch on the rear panel is not in the appropriate position at power up (see Sections 2.5.2 and 3.4, item 3), the test sequence will stop at the error 18 message.

11. The Options Checksum Test is performed (see Section 5.4.10, entry number 22). The LEVEL display will briefly show the test number "22".

12. If the GPIB option is installed, then the GPIB Data Exchange Test is performed (automatic power up test number 80; described in the GPIB documentation provided in Section 6.4 of this manual).

13. The Sticking Key Test is performed (automatic power up test number 81). If a key is sticking, an "Err" message will begin blinking on/off in the MODULATION display. The key code number associated with the sticking key will be shown in the LEVEL display. (Key codes are shown in Table 5-3.)

5.6.2 Any error that occurs during the power up test sequence will generate the error message associated with the test. The MODULATION display will show "Err". The LEVEL display will show an "xx" value indicating the error code. The error message "Err" will blink on/off. Testing will be halted at the failure point. The operator may continue the test sequence beyond the failed test by turning the spin knob. The 2520 will proceed to the next step in the test sequence.

5.6.3 If the front panel displays do not operate (are blank or exhibit erratic, unclear messages), the Model 2520 is inoperable and needs repair. (Wavetek provides an optional Service Manual containing information useful to troubleshooting/repair of the Model 2520. The Service Manual contains schematic and assembly reference drawings, a detailed theory of operation, replaceable parts lists, and a generalized troubleshooting guide. Wavetek recommends the unit be returned to the factory, after factory authorization, for any repair work.)

5.6.4 When all tests have been performed successfully the FREQUENCY display will indicate "CHEC PASS". The LEVEL display will show the software version installed in the unit. (For example, "r 4.0" indicates "release version 4.0".)

5.6.5 The unit will now be ready for normal operation as detailed in Section 3 of this manual.

6.1 INTRODUCTION

The optional general purpose interface bus (GPIB) for the Model 2520 is fully compatible with IEEE Std 488-1978. The following interface functions are implemented.

- SH1 Complete source handshake capability
- AH1 Complete acceptor handshake capability
- T6 Basic talker, serial poll; unaddressed if MLA (my listen address) is active; talk only mode disabled
- TE0 Extended talker mode disabled
- L4 Basic listener; unaddressed if MTA (my talk address) is active; listen only mode disabled
- LE0 Extended listener mode disabled
- RL1 Complete Remote/Local capability
- PP0 Parallel poll capability disabled
- DC1 Complete device clear capability
- DT1 Complete device trigger capability
- C0 Controller capability disabled
- E2 Device dependent code to data line to indicate end of string; bit 2 (of bits 1-8) must be set.
- SR1 Complete service request capability

All instrument functions except Power On/Off, the Up/Down (↑ ↓) increment keys, the AutoCal® procedures, and the User Diagnostics may be set via the GPIB. The Model 2520 is both a listener and a talker over the GPIB and provides error status and instrument status to its associated computer/controller.

The GPIB command format uses the minimum uniqueness concept to allow considerable flexibility in programming the 2520 functions. Because of this flexibility the Model 2520 with GPIB can be easily conformed to any GPIB based Automated Test Equipment (ATE) system and is fully compatible with the Wavetek Models 2500 and 2500A Signal Generators.

6.2 INSTALLATION INSTRUCTIONS

The GPIB circuitry is located on the GPIB card inside the Model 2520. The bus address (My Listen Address; MLA) for the Model 2520 is factory preset at "2", but this may be changed over the GPIB or from the front panel (see Section 5.4.10, entry number 21) if desired. Installation associated with GPIB control of the 2520 consists of using a GPIB cable to connect a GPIB controller to the GPIB connector on the rear panel of the 2520.

A GPIB controller is a digital computer that has I/O interface hardware and an operating system that is compatible with the IEEE-488 standard. The controller sends ASCII command strings over the GPIB to control a GPIB instrument.

Verify GPIB operation by sending the simple carrier frequency command "FRQ 200 MHZ" over the bus. (The complete command entry will depend upon the controller used. See Sections 6.3.5 and 6.3.9 for greater detail.) The 2520 FREQUENCY display will show 200 MHz and the MODULATION display will show the REMOTE annunciator if installation is correct.

6.3 OPERATING INSTRUCTIONS

6.3.1 LOCAL/REMOTE MODE SELECTION

When power is first applied to the Model 2520 the instrument will be in the Local Mode of operation. All functions will be controlled from the front panel. The 2520 will enter the Remote Mode of operation after any valid command has been transferred over the GPIB bus. When the 2520 is in the remote mode, the front panel keypad is inactive with two possible exceptions. The LCL key may be used to switch operation back to the Local Mode if the Local Lockout bus command has not been sent by the controller. The SRQ key may be used to generate a Service Request (SRQ) if the controller has sent an SRQ enable over the GPIB. Note that if the GPIB has been used to send Local Lockout and SRQ disable commands to the 2520, the 2520 front panel is totally inactive (except for the power on/off switch) and the keyboard cannot be used to make changes in operating functions/values.

Three procedures may be used to switch from remote mode to local mode. The operator may cycle power (turn the 2520 off, then on), with power up in the local mode. The operator may press the LCL key on the 2520 front panel (if the Local Lockout Command has not been sent over the GPIB). The operator may send the return to local mode (RTL) command over the GPIB. Either of these three procedures will return control to the 2520 front panel. The unit will not enter the local mode while valid GPIB commands are being sent.

6.3.2 ADDRESS SETTING

The MLA (My Listen Address), the 2520 instrument bus address, is programmable over the GPIB or from the front panel (see Section 5.4.10, entry number 21). The power up (default) address is factory preset at "2" using a DIP switch on the GPIB card. The default MLA can be changed by physically re-setting the DIP switch positions (a procedure described in the optional Model 2520 Service Manual because it involves opening up the unit). SIG (signal generator), MLA (my listen address), and MTA (my talk address) are all methods of changing the programmable instrument address over the GPIB bus. The talk and listen addresses must be the same. Only a decimal address of 0-30 is allowed. An error will be generated if the programmed address is out of range and the current address is not changed.The address read from the DIP switch is the power-up default address. The 2520 allows only primary addressing.

6.3.3 GPIB INPUT COMMAND DEFINITION

A GPIB input command is a statement generated at the controller and communicated to the 2520 by the GPIB that causes the 2520 to execute a particular function or establish a particular setting.

The Wavetek 2520 GPIB recognizes a variety of input commands to provide maximum user friendliness. The majority of GPIB input commands are identical in format to their corresponding manual inputs (using the 2520 front panel keyboard). The remaining GPIB commands are used to obtain system status information or to change system status.

6.3.4 GPIB INPUT COMMAND TYPES

There are four (4) basic types of GPIB input commands: parameter, enumerated, direct, and query. Each type of command and its format are described in the following sections. GPIB commands use the minimum uniqueness concept to enhance user friendliness (see below).

6.3.5 PARAMETER COMMANDS

Parameter commands are commands that change numerical values of the 2520 operational settings (output frequency, output level, etc.) A parameter command specifies a particular numerical value for an instrument setting.

The parameter command format is:

<header> space <numeric argument> <terminator>

6.3.5.1

Parameter command headers are shown and described in Table 6-1. Characters (letters) may be entered in upper or lower case. Each header must contain a minimum number of letters in a specific order. The minimum format is the minimum set of letters in the specific order shown that will identify the operating parameter described. Each header has a maximum length format. The maximum format is the maximum set of characters for identification of the parameter. To specify a parameter command header the operator may use the minimum format, maximum format, or any combination of letters between the minimum and maximum format that includes the minimum format characters in their specified order. This is the minimum uniqueness concept. For example, the header for a command to alter center frequency may be entered as "FRQ", "FREQ", or "FREQUENCY". Three parameter commands (MLA, MTA, and SIG) have identical minimum and maximum formats.

6.3.5.2

After the header is entered, a space character must be entered to separate the header from the numeric argument of the parameter command format. Note that after this required space has been entered, spaces may be included anywhere else in the command string at the users' option (to make the user's program more easily readable, for example).

6.3.5.3

The numeric argument consists of a number and the applicable engineering notation for the units associated with the parameter entered. The general form for a numeric argument is: (sign) (9 digits and decimal point) (engineering notation). If no sign is entered the 2520 will assume the numeric value is positive (the sign is positive). The 2520 will accept a number that has a maximum of nine digits and has a decimal point anywhere within the nine digits entered. The operator may enter any number of digits from 1 to 9. The 2520 will ignore any digits entered after the ninth digit.

Table 6-1. Parameter Command Headers

MINIMUM FORMAT	MAXIMUM FORMAT	DESCRIPTION
FRQ	FREQUENCY	Output Frequency
FST	FREQUENCYSTEP	Frequency Step Interval
LVL	LEVEL	Output Level
LST	LEVELSTEP	Output Level Step Interval
IAM	INTERNALAM	Internal Amplitude Modulation
IFM	INTERNALFM	Internal Frequency Modulation
XAM	EXTERNALAM	External Amplitude Modulation
XFM	EXTERNALFM	External Frequency Modulation
RTE	RATE	Internal Modulation Rate
STR	STORE	Storage of an Instrument Setting
RCL	RECALL	Recall of an Instrument Setting
MLA	MLA	Programmable Talk and Listen Address
MTA	MTA	Programmable Talk and Listen Address
SIG	SIG	Programmable Talk and Listen Address

6.3.5.4

The number may be entered in scientific notation, using a two digit exponent value that is not part of the nine digit maximum. Scientific notation takes the form: (E) (sign) (digit 1) (digit 2). The sign and the second digit are optional. If no sign is entered, the 2520 will assume the sign is positive. The "E" character (for exponent) may be entered in upper or lower case. The general form for the number part of a numeric argument entered in scientific notation is: (overall sign) (9 digits) (decimal point) (E) (exponent sign) (digit 1) (digit 2).

The general form for a numeric argument with scientific notation is: (sign) (9 digits) (decimal point) (E) (exponent sign) (digit 1) (digit 2) (engineering notation).

6.3.5.5

The engineering notation for the units associated with the parameter entered may contain additional numeric information. For example, kHz is 1000 Hz. Therefore, an entry of 3.000 kHz is an entry of 3000 Hz. Engineering notation is shown in Table 6-2, below. Note that GHZ, GZ, MHZ, MZ, KHZ, KZ, MV and UV provide numeric and engineering unit information. Engineering notation may be entered in upper or lower case or any combination of the two.

6.3.5.6

The numeric values for the parameter command arguments have the ranges specified as normal ranges for the 2520 signal generator functions. The internal modulation rate (RTE) argument can have only the values "400" and "1000" Hz. The RTE argument does not require an engineering notation (HZ) entry.

6.3.5.7

The arguments for the storage (STR) and recall (RCL) of a complete front panel setting are limited to values between 1 and 64. The STR/RCL function is a unitless value requiring no engineering notation as part of its argument. The programmable talk and listen address commands (MLA, MTA, and SIG) are limited to values between 0 and 30 and also are unitless. MLA (my listen address), MTA (my talk address), and SIG (signal generator) are all commands

Table 6-2. Engineering Notation

NOTATION	ASSOCIATED PARAMETER
GHZ	Output Frequency
GZ	Output Frequency
MHZ	Output Frequency
MZ	Output Frequency
KHZ	Output Frequency, Internal FM, External FM
KZ	Output Frequency, Internal FM, External FM
HZ	Output Frequency, Internal FM, External FM
DB	Output Level
DBM	Output Level
MV	Output Level
UV	Output Level
V	Output Level
%	Internal AM, External AM

to change the programmable instrument address over the GPIB instead of changing the address from the front panel or the DIP switches in the 2520 GPIB hardware. The talk and listen addresses must be the same.

6.3.5.8

The final item in the generalized parameter command format is an end of string (EOS) terminator. A series of parameter commands may be entered at the controller before any single command in the series is executed across the GPIB. The series is called a string of commands. The EOS terminator tells the controller to send the entered command or string of commands to the 2520. The commands in a string of commands are separated from one another by semicolons after each command's engineering notation. The EOS tells the controller that the entered sequence has been concluded. The EOS terminators are factory set to CR/LF/EOI. These are the default EOS terminators. The operator may set the EOS terminators from the front panel (see Section 5.4.10, entry number 21).

A hardware switch inside the 2520 may be set to select other commonly used EOS terminator sequences. This procedure is described in the optional 2520 Service Manual because it involves opening up the unit. (The operator may establish a different EOS terminator of 1, 2, or 3 characters by performing the GPIB enumerated command identified as TRM in Section 6.3.6, immediately following this section).

6.3.6 ENUMERATED COMMANDS

Enumerated commands, with one exception, are commands that provide distinct choices to change system status. The modulation off command (see Table 6-3) has no alternative choices. Enumerated commands follow the format: <header> space <alphabetic or ASCII control symbol argument> <terminator>.

6.3.6.1

Enumerated command headers and their associated arguments are shown in Table 6-3. The majority of commands require an alphabetic argument. Argument characters may be in upper or lower case or any combination of the two. The EOS terminator command requires use of an ASCII control symbol(s). A brief description of each command function is included in Table 6-3. More information about each command is contained in the following sections, as required.

It is the minimum format for enumerated command headers that is shown in Table 6-3. These headers also employ the minimum uniqueness concept (Section 6.3.5.1) to provide expanded user friendliness. Minimum and maximum formats for enumerated command headers are shown in Table 6-4.

6.3.6.2

A space character must be entered between an enumerated command header and its argument. Additional spaces may be entered anywhere else in the command string as desired (to aid in reading a program, for example).

6.3.6.3

The final item in an enumerated command is the EOS (end of string) terminator. The discussion of EOS terminators of parameter commands in Section 6.3.5.8 is equally applicable for enumerated commands.

6.3.6.4

When enabled, the front panel SRQ (Service Request) function allows the 2520 to signal to the GPIB controller that the 2520 is requesting attention. The SRQ function is activated when the front panel SRQ key is pressed. The SRQ will signal the controller if an error condition exists within the 2520. The SRQ function is disabled at 2520 power

Table 6-3. Enumerated Command Listings

HEADER	ARGUMENT	DESCRIPTION
RF	ON	RF output signal enabled at the RF OUT connector on the 2520 front panel
RF	OFF	RF output signal disabled at the RF OUT connector on the 2520 front panel
MOD	OFF	All modulation is disabled: internal and external AM, and internal and external FM **NOTE** MOD ON is not a valid command. The specific modulation desired must be entered as a separate parameter command (see Section 6.3.5, ff).
RQS	ON	Enable the 2520 to produce service requests
RQS	OFF	Disable all service requests
GET	ON	Execute the previously transmitted group of functions
GET	OFF	Disable the group execution or group input
GET	SS	Execute the next stored setting
TRM	1, 2, or 3 ASCII control symbols at user's discretion	Programmable end of string terminator (see Section 6.3.5.8).

Table 6-4. Enumerated Command Headers

MINIMUM FORMAT	MAXIMUM FORMAT	COMMAND NAME
RF	RF	RF Signal Output
MOD	MOD	Modulation
RQS	REQUESTFORSERV	Request for Service (Service Request)
GET	GET	Group Execute Function
TRM	TERMINATORS	Programmable End of String Terminators

up (the SRQ default condition). The SRQ function is identified on the GPIB as RQS (Request for Service) and is enabled by the GPIB enumerated command "RQS ON". The GPIB command "RQS OFF" will disable the SRQ function.

When an error generates an SRQ, the operator must send the query command "ERR" (discussed in Section 6.3.8) over the GPIB to receive a coded message identifying the source of the error. If the SRQ function is not enabled, the 2520 serial poll buffer will still contain the current status of the 2520. The SRQ can be enabled and the "ERR" command sent to the 2520 (and the 2520 will send back the appropriate error code).

Note that to utilize the 2520 SRQ capability the controller also must have complete service request (SRI) capability.

6.3.6.5

The GET (Group Execute Trigger) command is used to automatically execute a group of functions within the 2520. There are four (4) types of GET input commands:

1. GET precedes a group of commands which will be executed at one time. The commands following "GET" are stored until "GET ON" is received. At that time, the commands are passed to the 2520 and executed. GET storage is limited to 100 characters. If the length of the GET command string exceeds 100 characters, the excessive characters will write over the earlier GET entries.

2. GET ON sends the stored commands to the 2520 for group execution.

3. GET OFF disables the GET function and clears all stored commands.

4. GET SS calls up the "next" 2520 stored setting and executes that setting. The stored settings calculated as "next settings" will refer only to settings that have been set up through the GPIB. This avoids having the controller query the 2520 to obtain the current stored setting, wait for the 2520 response, and then ask for a recall of the next setting.

The GET command also may be used to simultaneously trigger a group of devices (instruments) on the GPIB.

6.3.6.6

The TRM (programmable terminator) function allows the user to select a maximum of three end of string termination ASCII control characters. A minimum of one character is required. The terminator command must always be completed with a semi-colon. The current EOS terminator is not a valid completion indication for this command because a resetting of the EOS is occurring as the TRM command is given. If the terminator input process is incorrect, an error will be generated and the current termination string will not be changed. To request an EOS control signal over the GPIB without actually resetting the EOS as the TRM is given, the user can include an ASCII " " as part of the termination string.

The general format for the TRM command is: TRM (char1); or TRM (char1)(char2); or TRM (char1)(char2)(char3);.

Aside from the semi-colon, any ASCII control character may be used as a terminator character. The minimum format header TRM is shown (see Section 6.3.5.1 for a brief discussion of the minimum uniqueness concept, if necessary).

6.3.7 DIRECT COMMANDS

Direct commands make the 2520 perform an immediate action. The format for a direct command is:<header><terminator>.

6.3.7.1

The header specifies the action to be performed. Minimum and maximum formats for the direct command headers and command name are shown in Table 6-5. The minimum uniqueness concept discussed in Section 6.3.5.1 is equally applicable for direct command headers.

6.3.7.2

The terminator description of Section 6.3.5.8 is equally applicable for the direct command format.

6.3.7.3

The LLO (Local Lock Out) command disables the 2520 front panel controls with the exception of the power on/off switch. The front panel LCL key cannot be used to return the 2520 to local control when the GPIB command LLO has been entered at the controller.

6.3.7.4

The RTL (Return to Local) command will return 2520 control to the 2520 front panel (local mode of operation).

6.3.8 QUERY COMMANDS

Query commands tell the 2520 to send 2520 operating parameters/status information to the controller. Using query commands, the 2520 is capable of informing the GPIB controller of: 1) the 2520's identity and operational status; 2) certain error conditions which have occurred; 3) the need for immediate attention. The query command format is: <header> <?> <terminator>.

6.3.8.1

The header specifies the type of information to be sent to the controller. The majority of the parameter command headers (Section 6.3.5.1) and enumerated command headers RF and MOD also serve as query command headers. Table 6-6 lists all query command headers (minimum format) and the associated 2520 response to the command. The 2520 responses to commands ID, ERR, OPT, and SET are discussed in detail in Sections 6.3.8.4, 6.3.8.5, 6.3.8.6, and 6.3.8.7, respectively. Note that information about 2520 output level (LVL) may be supplied to the controller in units of volts, mV, µV, or dBm. There are seven possible responses to a "MOD" query, and two responses to both "RF" and "RTE" queries.

All response messages will utilize a fixed message length of 30 characters. Blanks will be inserted as necessary at the end of the message to complete the message length.

Table 6-6 lists query command headers in minimum format. The minimum uniqueness concept of Section 6.3.5.1 is valid for query commands also. Header formats for all commands but ID, ERR, OPT, and SET have been presented earlier in this section. Header formats for ID, ERR, OPT, and SET are shown in Table 6-7.

6.3.8.2

Because parameter and enumerated command headers can also be query headers, the question mark <?> in the query command format tells the 2520 to send information, rather than receive information. The query command "<FRQ> <?> <terminator>" requests the current operational output frequency setting for the 2520.

6.3.8.3

The terminator characters in a query command are exactly as described in Section 6.3.5.8 for parameter commands.

6.3.8.4

The response of the 2520 to the query command ID (Identify) will be "ID WVTK/2520,V81.1,Fx.x", where: WVTK/2520 is the Wavetek model number 2520; V81.1 is the version of Tektronix Codes and Formats utilized in the firmware design; Fx.x is the firmware version number.

Table 6-5. Direct Command Headers

MINIMUM FORMAT	MAXIMUM FORMAT	COMMAND NAME
LLO	LOCALLOCKOUT	Lockout of Front Panel
RTL	RETURNTOLOCAL	Return Instrument to Local Control

Table 6-6. Query Command Headers/2520 Response

HEADER	2520 RESPONSE
FRQ	FREQUENCY ffff.ffff MHz
FST	FREQ STEP ffff.ffff MHz, kHz, or Hz
LVL	AMPLITUDE aaaa Volts
	AMPLITUDE aaa.a dBm
LST	AMP STEP aaaa Volts
	AMP STEP aaaa mV
	AMP STEP aaaa μV
	AMP STEP aaa.a dBm
RF	RF OUTPUT ON
	RF OUTPUT OFF
IAM	INTERNAL AM mm %
IFM	INTERNAL FM mmmm kHz
XAM	EXTERNAL AM mm %
XFM	EXTERNAL FM mmmm kHz
RTE	MOD RATE 400 Hz
	MOD RATE 1000 Hz
MOD	MODULATION OFF
	MODULATION INT AM / EXT FM
	MODULATION EXT AM / INT FM
	MODULATION INT AM
	MODULATION INT FM
	MODULATION EXT AM
	MODULATION EXT FM
ID	ID WAVETEK/2520, V81.1, Fx.x
ERR	xxx-ENGLISH DESCRIPTION
OPT	OPT xx - ENGLISH DESCRIPTION
SET	CURRENT 2520 SETTINGS

Table 6-7. Header Formats for ID, ERR, and SET Query Commands

MINIMUM FORMAT	MAXIMUM FORMAT	DESCRIPTION
ID	IDENTIFY	Request for the instrument name and model
ERR	ERROR	Request for the current listing of errors
OPT	OPTIONS	Request for a list of programmed options
SET	SET	Request for a listing of the current instrument settings

6.3.8.5

The 2520 will respond to the query command ERR (Error) with error messages that identify the source of a detected error(s). The general format of an error message is:

XXX-ENGLISH DESCRIPTION OF THE ERROR

where XXX is an identifier which is used to identify the error. To maintain the fixed message length of 30 characters, the total error message will be kept to 30 characters. Error messages are shown in Table 6-8.

When an error is detected, the 2520 serial poll byte will be filled with an eight bit number which will classify the error. Bit 6 of the serial poll byte will be set for a request for service. During normal operation the buffer will contain the decimal value 128. The decimal values for error classifications available are as follows:

97	Command Error
98	Execution Error
99	Internal Error
6X	System Events X = 0 through 9

Table 6-8.
Error Messages/Serial Poll Byte
(decimal values)

ERROR MESSAGE	SERIAL POLL BYTE
101-COMMAND HEADER	97
103-ARGUMENT	97
205-ARGUMENT OUT OF RANGE	98
302-SYSTEM ERROR	99
310-LO UNLOCKED	99
311-MAIN LOOP UNLOCKED	99
312-UNIT UNLEVELED	99
313-CIRCUIT BREAKER TRIPPED	99
314-FM OVERMODULATION	99
315-400 HZ NOT FUNCTIONAL	99
316-UPPER FREQUENCY UNLEVELED	99
341-CONTROL-TO-GPIB ERROR	99
349-POWER UP SETTINGS ERROR	99
350-STORED SETTING ERROR	99
401-POWER UP	65
403-ID USER REQUEST	67
499-SYSTEM OPERATIONAL	128

The decimal value for the serial poll byte associated with each error message also is shown in Table 6-8.

If there is no message to send but a talk request has been made, the 2520 will respond with a 255 in the serial poll byte. This will happen if the error message buffer is empty.

6.3.8.6

The 2520 will respond to the query command OPT (Options) with a listing of options programmed for the unit. If no options have been programmed into the unit, the OPT response is "No options installed". If programmed options are available, one option will be presented per message line. The message format is "OPT xx: English description of the option". The "xx" part of the message is the option key code shown in Table 5-3 of this manual. The english descriptions associated with each key code are:

OPT 6B:Frequency Shift Keying
OPT 70:External Pulse Mod
OPT 6F:Level Step
OPT 79:Internal Phase Mod
OPT 7A:External Phase Mod
OPT 77:50 Radians Peak Phase

The user will need to program the computer/controller to perform continuous "READS" in order to obtain all options (without performing a manual "READ" after each message line).

If the user requests an option that has not been programmed or inputs information for an option that has not been programmed, the response across the bus will be "Option not Available".

The SET query (Section 6.3.8.7) will generate the standard instrument settings and the options list.

6.3.8.7

The response of the 2520 to a SET query (SET?) will be the current operational settings of the instrument and its programmed options as shown in Table 6-9. Each setting will be sent as an individual message. The user will need to program the computer/controller to perform continuous "READS" in order to obtain all ten settings and options in sequence (without performing a manual "READ" after each message).

Table 6-9. Set (?) Response

FREQUENCY
FREQ STEP
AMPLITUDE
INTERNAL AM
INTERNAL FM
EXTERNAL AM
EXTERNAL FM
RF OUTPUT (on/off)
MOD RATE
MODULATION (OFF or the types of active Modulation: INT AM, EXT AM, INT FM, EXT FM)
AMP STEP
OPTION LIST (see Section 6.3.8.6).

6.3.9 SAMPLE SOFTWARE PROGRAMS

These basic programs can be adapted to any GPIB controller if the appropriate write and address formats are substituted. These programs illustrate the 2520 as a listener. The 2520 is also a talker. Please note that Wavetek Marketing Engineers can provide assistance for interfacing various controllers to the Model 2520 (call 317-788-9351).

6.3.9.1 FUNCTION: FREQUENCY

Exercise: Program the frequency in 50 MHz steps between 100 and 1100 MHz.

```
WAVETEK 6000 BASIC:
100 FOR I=100 to 1100 STEP 50
110 WRITE @ 702:"FRQ "&STR$(I)& "MHZ;"
120 WAIT DELAY.2
130 NEXT I
140 END
```

The 200 millisecond time delay in line 120 permits the Model 2520 frequency to stabilize.

```
HP85 BASIC:
100 FOR I=100 to 1100 STEP 50
110 OUTPUT 702;"FRQ "&VAL$(I)&"MHZ;"
120 WAIT 200
130 NEXT I
140 END

HP9825 HPL:
0: for I=100 to 1100 by 50
1: wrt 702,"FRQ "&str(I)&"MHZ;"
2: wait 200
3: next I
4: end

IBM PC BASIC:
100 for I=100 to 1100 STEP 50
110 I$=RIGHT$(STR$(I),LEN(STR$(I))-1)
120 WRT$="FRQ "+I$+"MHZ;"
130 CALL IBWRT(SIGEN%,WRT$)
140 FOR J=1 to 200
150 NEXT J
160 NEXT I
170 END
```

In line 110 a blank space is removed to prevent an illegal response.

In lines 140 and 150 an approximate delay is achieved by using a for-next 1000.

NOTE: The necessary program lines that initialize the PC, set the device number, and clear the 2520 (NAME: SIGEN) are omitted from the above program.

6.3.9.2 FUNCTION: LEVEL

Program the output level in 5 dB steps between +10 and -100 dBm. Initially set the frequency to 500 MHz in CW mode with the RF output on.

```
WAVETEK 6000 BASIC:
100 WRITE@702:"FRQ 500 MHz; MOD OFF;
    RF ON;"
```

```
110 WAIT DELAY .2
120 FOR I=10 TO -100 STEP -5
130 WRITE@702:"LVL "&STR$(I)& "DBM;"
140 NEXT I
150 END
```

```
HP 85 BASIC:
100 OUTPUT 702:"FRQ 500MHz; MOD
    OFF; RF ON;"
110 WAIT 200
120 FOR I=10 to -100 STEP -5
130 OUTPUT702;"LVL "&VAL$(I)& "DBM;"
140 NEXT I
150 END
```

```
HP 9825 HPL:
0: wrt 702,"FRQ 500MHZ;MOD OFF;RF ON;"
1: wait 200
2: for I=10 to -100 by -5
3: wrt702,"LVL "&STR(I)&"DBM;"
4: next I
5: end
```

```
IBM PC BASIC:
100 WRT$-"FRQ 500 MHZ;MOD OFF;RF ON;"
110 FOR I=1 to 200
120 NEXT I
130 FOR I=10 TO -100 STEP -5
140 I$=RIGHT$(STR$(I),LEN(STR$(I))-1
150 WRT$="LVL "+I$+"DBM;"
160 CALL IBWRT(SIGEN%,WRT$)
170 NEXT I
180 END
```

6.3.9.3 FUNCTION: RF LEVEL (ON/OFF)

Set the Model 2520 to 1000 MHz at +13 dBm in CW mode with the RF output off for 400 milliseconds, then on for 200 milliseconds, then off again.

```
WAVETEK 6000 BASIC:
100 WRITE@702:"FRQ 1000MHZ;
    MOD OFF; RF OFF;"
110 WAIT DELAY .4
120 WRITE@702:"RF ON;"
130 WAIT DELAY .2
140 WRITE@702:"RF OFF;"
150 END
```

```
HP 85 BASIC:
100 OUTPUT 702:"FRQ 1000MHZ; MOD OFF;
    RF OFF;"
110 WAIT 400
120 OUTPUT702;"RF ON;"
130 WAIT 200
140 OUTPUT702;"RF OFF;"
150 END
```

```
HP 9825 HPL:
0: wrt702,"FRQ 1000MHZ; MOD OFF;
   RF OFF;"
1: wait 400
2: wrt702,"RF ON;"
3: wait 200
4: wrt702,"RF OFF;"
5: end
```

```
IBM PC BASIC:
100 WRT$="FRQ 1000MHZ; MOD OFF;
    RF OFF;"
110 CALL IBWRT(SIGEN%,WRT$)
120 FOR I=1 to 400
130 NEXT I
140 WRT$="RF ON;":CALL IBWRT (SIGEN%,
    WRT$)
150 FOR I=1 to 200
160 NEXT I
170 WRT$="RF OFF;":CALL IBWRT
    (SIGEN%,WRT$)
180 END
```

6.3.9.4 FUNCTION: INTERNAL FM

Initially set the Model 2520 to 750 MHz at +10 dBm in CW mode with RF output on. After 1 second, set the internal FM deviation to 500 kHz at 1 kHz modulation rate. After 500 milliseconds turn the modulation off.

```
WAVETEK 6000 BASIC:
100 WRITE@702:"FRQ 750MHZ;
    LVL 10DBM ; MOD OFF;RF ON;"
110 WAIT 1
120 WRITE@702:"IFM 500KHZ;RTE 1000;"
130 WAIT .5
140 WRITE@702:"MOD OFF;"
150 END
```

```
HP 85 BASIC:
100 OUTPUT 702;"FRQ 750MHZ;
    LVL 10 DBM; MOD OFF; RF ON;"
110 WAIT 1000
120 OUTPUT702;"IFM 500KHZ; RTE 1000;"
130 WAIT 500
140 OUTPUT702;"MOD OFF;"
150 END
```

```
HP 9825 HPL:
0: wrt702,"FRQ 750MHZ; LVL 10DBM;
   MOD OFF; RF ON;"
1: wait 1000
2: wrt702,"IFM 500KHZ; RTE 1000;"
3: wait 500
4: wrt702,"MOD OFF;"
5: end

IBM PC BASIC:
100 WRT$="FRQ 750MHZ; LVL 10DBM;
    MOD OFF; RF OFF;"
110 CALL IBWRT(SIGEN%,WRT$)
120 FOR I=1 to 1000
130 NEXT I
140 WRT$="IFM 500KHZ; RTE 1000;"
150 CALL IBWRT(SIGEN%,WRT$)
160 FOR I=1 TO 500
170 NEXT I
180 WRT$="MOD OFF;":CALL IBWRT
    (SIGEN%,WRT$)
190 END
```

6.4 GPIB DATA EXCHANGE TEST

The GPIB Data Exchange Test (test number 80) is part of the Power Up Test executed automatically when the unit is turned on. (The sequence of power up tests executed is described in Section 5.5 of this manual).

6.4.1

The purpose of the GPIB Data Exchange Test is to verify functional operation of the communication path between the 2520 processor board and the GPIB board.

6.4.2

During the test the number "80" will be shown on the LEVEL display to indicate the test is in progress.

6.4.3

If an error is detected during the test, the MODULATION display will show the message "Err" blinking on and off.

6.5 GPIB BOARD TEST (USER DIAGNOSTIC)

The GPIB Board Test is part of the Model 2520 user diagnostics package described in Section 5.4 of this manual. The procedures to activate the user diagnostics, select a particular test, and general information about diagnostics are detailed in Sections 5.4.1 to 5.4.9.

6.5.1

The purpose of the GPIB Board Test (entry number 09) is to verify the operation of the ROM and RAM associated with the GPIB processor board. The factory default settings for the GPIB address and end of string (EOS) terminator are activated (and displayed) by this test.

6.5.2

During the test, the number "09" will be shown on the LEVEL display to indicate the test is in progress. If the GPIB option is not installed, then the message "no gpib" will be shown on the FREQUENCY display for approximately two seconds. The message "SEL 01-22" will then return to the FREQUENCY display. If the GPIB option is installed, the following tests are performed.

6.5.2.1

First the RAM on the GPIB board is tested. During this test, "gpib 1" is shown on the FREQUENCY display. If an error with the RAM is detected, then the standard "Err" message will blink on/off in the MODULATION display. Turn the spin knob to continue the GPIB test.

6.5.2.2

Next, the ROM on the GPIB board is tested. During this test, "gpib 2" is shown on the FREQUENCY display. If an

error with the ROM is detected, then the standard "Err" message will blink on/off in the MODULATION display. Turn the spin knob to continue the GPIB test.

6.5.2.3

After the RAM and ROM tests have been completed, the factory default settings for the GPIB hardware address and terminator are displayed and are the active settings. The hardware settings override any previously programmed settings when the GPIB Board Test is performed. The GPIB address number will be shown in the FREQUENCY display as "xx GPIB ADDR" where xx is the address number 0-64. The annunciator TERM and a code representing the GPIB terminator will be shown in the FREQUENCY display. The four possible terminator codes are:

LF - Line Feed only
LF/EOI - Line Feed and End or Identify
CR/LF/EOI - Carriage Return, Line Feed, and End or Identify
LAST CHAR/EOI - Last character and End or Identify

6.5.2.4

Throughout the GPIB Board Test, the communications between the GPIB board and the 2520 processor board are checked. If the response from the GPIB board is faulty at any time during the test, then the message "gpib rsp" is shown on the FREQUENCY display and the standard "Err" message will blink on/off on the MODULATION display. Turning the spin knob will terminate the GPIB Board Test, skipping the remainder of the test.

6.5.3

If an error is detected during the test, the user may elect to discontinue further testing and begin trouble-shooting to determine/correct the problem causing the test failure (see Section 5.4.10). The user may elect to perform additional diagnostics by turning the spin knob to recall the "SEL 01-22" message on the FREQUENCY display.

6.5.4

After the successful completion of the test, the word "Pass" and then the "SEL 01-22" message will be shown on the FREQUENCY display. The operator may select "21" to reprogram the GPIB address and EOS terminator to their status prior to performing the GPIB Board test (see Section 5.4.10, entry number 21, if necessary). The operator may proceed with other diagnostics as desired.

7.1 INTRODUCTION

This section describes operation of the Phase Modulator and the Pulse Modulator options. (The optional general purpose interface bus, GPIB, is detailed in section 6 of this manual).

7.2 PHASE MODULATION

7.2.1 SPECIFICATIONS

Peak Phase Modulation	19.99 rad (3 - 137.49999 MHz) 9.99 rad (137.5 - 274.9999 MHz) 19.99 rad (275 - 2200 MHz)
3 dB Band Width	20 Hz - 50 kHz
Accuracy	± 6%

7.2.2 OPERATION

Phase modulation is controlled completely from the front panel. Connect the phase modulation signal (20 Hz - 50 kHz rate, 1 volt peak-to-peak) to the front panel "Mod In" connector. Press the EXT Ø MOD pushbutton key. Enter a radian deviation value from 0.00 to 19.99 or 9.99 (see specifications, above). Press the RAD pushbutton key. The Modulation display will show the radian deviation value entered.

To turn off phase modulation, press the MOD OFF pushbutton key.

To enable phase modulation across the GPIB (optional), type the minimum format command "XPH" through the maximum format "EXTERNALPHASEM".

When FSK (Frequency Shift Keying) and Phase Modulation are used simultaneously at frequencies from 3 - 137.49999 MHz or 275 - 2200 MHz, the maximum phase modulation (Ø max) in radians that may be entered is given by the formula:

$$Ø\ max = 9.99\ kHz - \frac{FSK\ deviation\ (in\ kHz)}{50\ kHz}$$

When FSK and Phase Modulation are used simultaneously at frequencies from 137.5 - 274.9999 MHz, Ø max is:

$$Ø\ max = 4.99\ kHz - \frac{FSK\ deviation\ (in\ kHz)}{50\ kHz}$$

Frequency Modulation and Phase Modulation can not be used simultaneously.

7.2.3 PERFORMANCE TEST

7.2.3.1 Test Equipment required

Modulation Analyzer, HP8901A, or equivalent

7.2.3.2 Test Procedure, Accuracy

1. Set the 2520 for 19.99 Radians of Phase Modulation and 275 MHz output frequency. Connect the modulation analyzer to the 2520 RF Out and set it to measure phase modulation in a 300 - 3 kHz post detection bandwidth. Connect a 1 kHz sine wave external modulation source (1 volt peak-to-peak) to the "Mod In" connector of the 2520. The analyzer should read between 18.80 and 21.18 radius.

2. Perform the above test at 2520 frequencies of 350 MHz, 425 MHz, and 500 MHz.

7.2.3.3 Test Procedure, 3 dB Bandwidth

1. Set the 2520 for 5 Radians of Phase modulation and 500 MHz output frequency.

2. Set the post detection bandwidth of the modulation analyzer to 50 Hz - 200 kHz.

3. Set the external modulation source to 1 kHz and 1 volt peak-to-peak.

4. Set the reading of the modulation analyzer to be the 0 dB reference.

5. Vary the external modulation source between 50 Hz and 20 kHz and verify that the relative phase modulation varies less than ±3 dB.

6. Repeat these checks at 2520 output frequencies of 100, 200, 400, and 1200 MHz.

7. Disconnect the test equipment. Turn off phase modulation.

7.2.4 MAINTENANCE

The phase modulation circuitry requires no periodic maintenance or calibration.

7.3 PULSE MODULATION

7.3.1 SPECIFICATIONS

FREQUENCY RANGE	DC to 2200 MHz

RF Output	+10 dBm to - 137 dBm
On/Off Ratio	>80 dB
Pulse Rise Time	<25 nsec
Pulse Fall Time	<25 nsec
Max Pulse Rate	1 MHz
On Delay <200 nsec, typically	
Off Delay	<100 nsec, typically
Input Impedance	50 OHM, pulse on or off
Pulse Input	TTL: +5 Volts = RF Off (Must not exceed 10 Volts). + 0 Volts = RF On Threshold Level = 1.4 Volts

7.3.2 OPERATION

Connect the pulse modulation signal (TTL: +5 volt high, 0 volt low; ≤1 MHz repetition rate) to the "Pulse In" connector on the front panel of the Wavetek Model 2520 Signal Generator. Press the EXT PM pushbutton key on the front panel. The EXT PM annunciator will appear on the Modulation display. The pulse modulator circuitry in the Wavetek Model 2520 Signal Generator will now modulate the RF Output in response to the external pulse modulation input.

Remember to turn the pulse modulation circuitry off (press the EXT PM front panel key) when pulse modulation is not used.

Pulse modulation may be enabled or disabled across the GPIB (optional) using the enumerated command format (section 6.3.6 of the Operating Manual). Type "XPL ON" to enable Pulse Modulation; type "XPL OFF" to disable Pulse Modulation. The minimum header format is"XPL." The maximum format is "EXTERNALPULSEM."

7.3.3 PERFORMANCE TEST, ON/OFF RATIO

7.3.1 Test equipment required

Spectrum analyzer with frequency range from .5 to 2200 MHz.

7.3.2 Test Procedure

1. Set the 2520 output level at +10 dBm and frequency at 2200 MHz.
2. Connect the spectrum analyzer to the 2520 RF output.
3. Attach the external pulse modulation input signal at the 2520 front panel "Pulse In" connector. Press the front panel EXT PM key to turn on the pulse modulator circuitry. Verify the EXT PM

annunciator appears on the Modulation display.

4. Set the input modulation signal at 0 volts. Verify the 2520 Output power is + 10 dBm.

5. Set the input pulse modulation signal at + 5 volts. Verify the RF power out is $\leq$ -70 dBm.

6. Repeat steps 4 and 5, above, for frequencies of 1100 MHz, 500 MHz, 100 MHz, and 1 MHz.

7. Disconnect the spectrum analyzer.

7.3.4 PERFORMANCE TEST, RISE/FALL TIME

7.3.4.1 Test Equipment Required

RF Detector, Wavetek Model D153 or eqivalent.

Oscilloscope, Tektronix 2465DVS or eqivalent (100 MHz input capability).

7.3.4.2 Test Procedure

1. Connect the Model 2520 RF Output to the D153 RF Detector and to the vertical input of the oscilloscope. Terminate the D153 RF Detector into 50 ohms (to eliminate a false reading due to the detector's time constant). Set the oscilloscope selector switch to 50 ohms.

2. Connect a pulse modulation input with pulse amplitude of 0 to +5 volts, rise/fall time <10 nsec, and a 1 MHz repetition rate to the 2520 front panel "Pulse In" connector. Turn on the pulse modulator circuitry by pressing the EXT PM key on the front panel.

3. Adjust the oscilloscope controls to observe the pulse rise and fall times as measured at 10% to 90% of the rise time and 90% to 10% of the fall time. Verify rise and fall times are each <40 nsec.

4. Disconnect the test equipment

5. Turn off the pulse modulator circuitry.

7.3.5 MAINTENANCE

The pulse modulator circuitry requires no periodic maintenance or calibration.

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